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A
ART of SHADOWS:

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47

Universal Dialling;

WITH

TABLES exactly Calculated for the Lat.
of 51 deg. 30 min. viz. London.

Teaching any Person, tho' of an ordinary Capacity, and
unlearned in the MATHEMATICKS, to draw a true
SUN-DIAL, upon any given PLAN, however Situated,
in respect of *Declination* and *Reclination*.

AND

A TABLE shewing the Distance of each Hour-line
from the *Meridian*, upon all *Horizontal-Dials*.

LIKEWISE

ARITHMETICAL,
SPOT, CONCAVE,
CONVEX,

}

}

INSTRUMENTAL,
REFLEX,
CYLINDRICAL.

D I A L L I N G.

WITH

The Manner of Ornamenting these several Sorts of Di-
alling with all Useful Furniture; and how to Cut the
five Regular Bodies, and two others, one of Twelve
Rhombs, and the other of Thirty.

The Third Edition, with Additions.

By JOHN GOOD, Teacher of Mathematicks.

L O N D O N:

Printed and Sold by THOMAS PAGE, and WILLIAM
MOUNT, on Tower-hill, 1731.





TO THE
READER.



HIS Treatise of Dialling consisteth, as before, of Geometrical and Instrumental Dialling: And the Acceptance it hath found among the Ingenious, hath Encouraged me to add a Third Part, namely, an Arithmetical way by the Canons of Artificial Sines and Tangents: And there are in it, as before, the Tables of Hour-distances of all declining Dials, from one deg. of Declination to 60 deg. which I have Calculated myself, and I think they are very exactly done, so that you may depend upon them. The Instruments by which Dialling may be performed are many, but amongst them all I think I have made choice of the Best, namely, a Ruler, accomodated with Scales and Lines necessary for that Purpose.

The First Scale, is a Scale of Hours, each Hour divided as the bigness of the Scale will permit, being proper for all Dials that have no Declination, as the Horizontal, the Direct South and North, whether Upright or Reclining; except the Stiles height be less than 10 deg. When that happens, there are other Scales for that Purpose; and this Scale hath the Letters (Hours) at the beginning.

The Second Scale, is a Scale of 90 deg. answerable to the Scale of Hours, and may be divided as the length of the Scale will give leave: This Scale and the first, will together shew how many deg. and min. of the Equinoctial under, &c.

To the READER.

The Third Scale, is a Scale of Longitude; known by the Letters (Lat.) at the beginning.

The Fourth and Fifth Scales, are two Scales of Hours of a different length, either of them will serve to make East West, Equinoctial, and Equinoctial declining Dials.

Both these Scales together, serve to draw all such Dials, whose Stile is but of small Elevation, and the Centre of the Dial is left out, and are known by the Letters (G. Pol.) and (L. Pol.) at the beginning.

It is proper to have two or three Lines of Chords, upon your Ruler, of several Raduses, and so have you a compleat Ruler.

And therefore if any Person be delighted with Recreation of this Nature, and hath not much Time to spend, they are here fitted with an Instrument which will dispatch presently and perform it exactly; they need not to fear to lose themselves in a Wilderness of Lines, nor out run the limits of the Plane, by infinite Excursion, (two inconveniencies which the common way of Geometrical Dialling is subject to,) they are here acquitted of both, having nothing to do but to draw the Dial itself, contracted within the Limits of the Plane. If any want Skill in the Mathematicks, let them not deterr from this Subject, for there is little required of them. If some think the Canon more exact so do I, but not so easy to be understood, nor so ready use, nor so speedy in performance, nor truly so well fitting the Capacities of all Persons. I shall say nothing in Commendation of this Book, hoping it will speak itself, I remain a Well wisher to the Mathematic

JOHN GOD

To the AUTHOR, on his Ingenious BOOK,
Intituled, The ART of SHADOWS: Or;
UNIVERSAL DIALLING.

I.

DOes Time (*sub Deo*) *nolens volens* Rule
The Universe with uncontrolled Sway?
Do both Nature and Art, Wiseman and Fool,
His Law of Limit, all alike Obey?
Do all visible things on Time depend:
In Time Begin, Perfect, and make their End?

II.

Does every Orb of each denomination,
Whether the fixed Orbs or Wanderers,
Keep Time's unbroken Law of Limitation:
By *Minutes, Hours, Days, Weeks, Months, & Years*?
Does Time's Progress admit of no Cessation,
'Till Eternity stop his Numeration?

III.

Is Time that's past beyond retriement lost,
Impossible to be restor'd again?
Does time that's present fly more swift than Post,
And ne'er one Moment, in one stay remain?
Can nothing stop Time's Feet, none hold his Wings,
Empires nor Emp'ors, Kingdoms nor their Kings?

IV.

Can neither Strength, Power, nor Policy?
Can neither Wisdom, Learning, Wit nor Art,
Riches, Grandeur, Honour, nor Majesty,
Stop Time's fleet Pace, or his Progress revert:
Nor Favour, nor Interest, nor Bribery
Stay Time's swift Passage to Eternity?

Does

V.

Does Time more swift than *Thought* or *Fancy* run
 Yet so, that he doth a fit Season lend
 To ev'ry Purpose underneath the Sun
 For to Begin, Perfect, and make its End ?
 Does Time rule all things, yet all things Obey
 That will accept his Service, while they may ?

VI.

If then, Time be the Best thing we Enjoy
 Of all *Sub-lunar* Blessings we receive ;
 And greatest Wisdom be, Time well t'Imploy ;
 Which being lost, we never can retrieve :
 Sure from these Premises, I may infer,
 To watch Time's Passage, should be our *chief care*.

VII.

If so, then sure sure I may. (without denial)
 Affirm that the most Useful Art, which by
 The *Art* of *Shadows*, or a *True made Dial*,
 From the Sun's bright Reflection, to each Eye,
 Doth shew us how, (by easy Definition)
 This swift Accomptant, sums up his Addition.

VIII.

Then sure above all, that e're writ the Art,
 From Plainness, Fulness, Shortness, and Perfection,
 GOOD doth this Universal Good impart,
 To all Capacities, by his Direction :
 For both by Instruments, and Calculation,
 GOOD above all, makes good his Application.

WM. BRITTAIN, *Philomath.*



BOOKS Printed and Sold by RICHARD
MOUNT and THOMAS PAGE; on
Tower-hill.

A TREATISE of *Trigonometry* Plane and Spherical,
Theoretical and Practical, in which the several Cases
of Plane and Spherical Triangles are solved Instrumental-
ly and Arithmetically; And likewise, A Treatise of *Ste-*
reographick and *Orthographick* Projection of the Sphere, in
which the Principals and Thoerems on which they de-
pend are clearly demonstrated, and the Practice naturally
deduced from those Demonstrations, Illustrated in the
Stereographick Projection of the several Cases in Right and
Oblique, Angled Spherical Triangles, so that the Requi-
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A. M. and R. S. S. To which is added Letters between
Sir

BOOKS Printed and Sold, &c.

Sir *Isaac Newton* and Mr. *Libnuire* relating to the first Inventor of *Fluxions*.

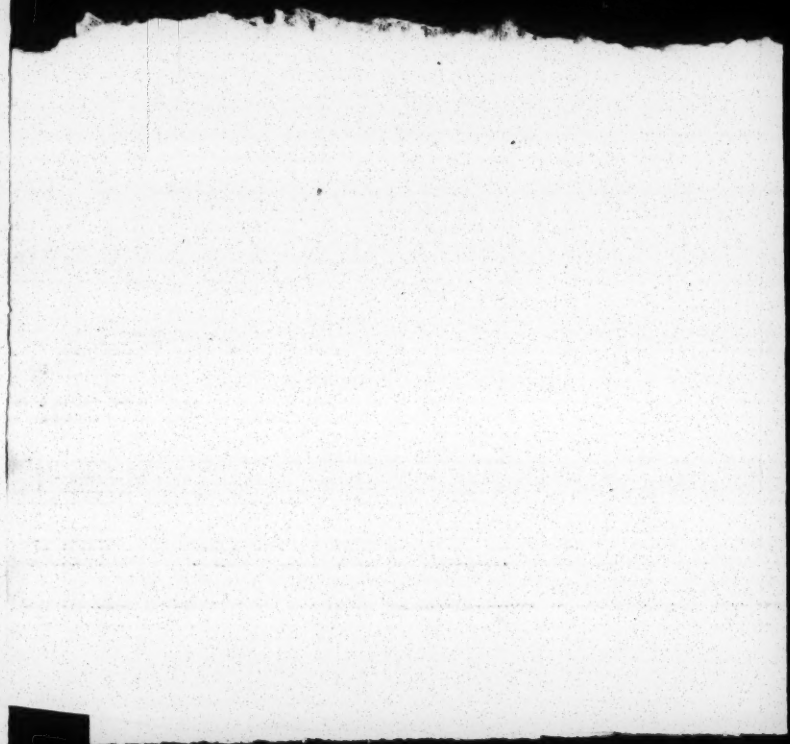
Geometry improv'd,

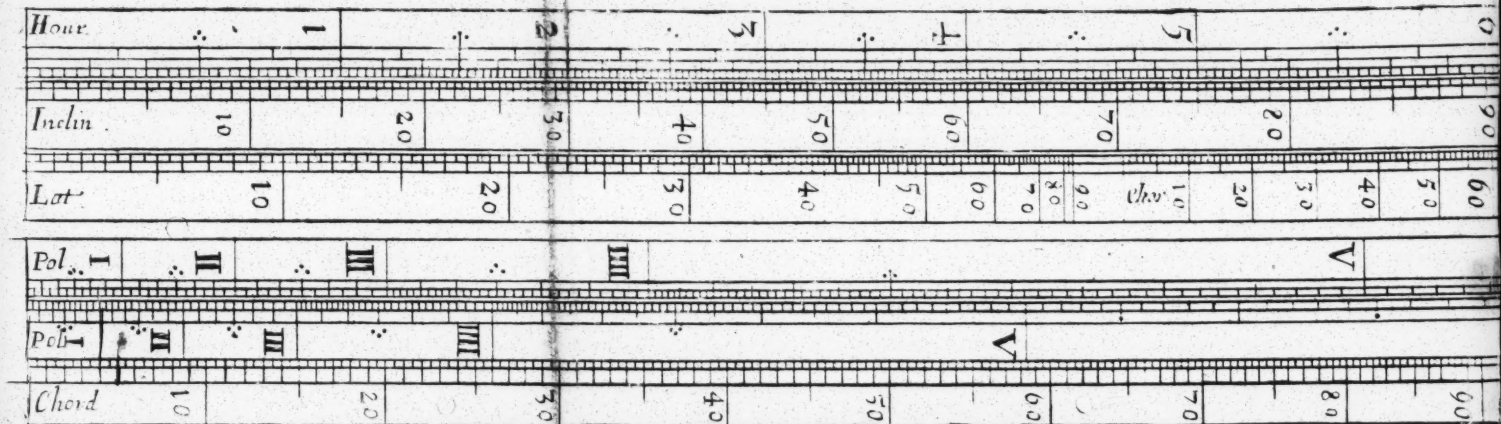
1. By a large and accurate Table of *Segments* of Circles, its Construction and various Uses of Solution of several difficult Problems, with Compendious Tables for finding a true proportional Part, and their Use in these or any other Tables exemplify'd in making out Logarithms or Natural Numbers from them to sixty Figures, there being a Table of them for all Primes to 1100 true to 61 Figures.

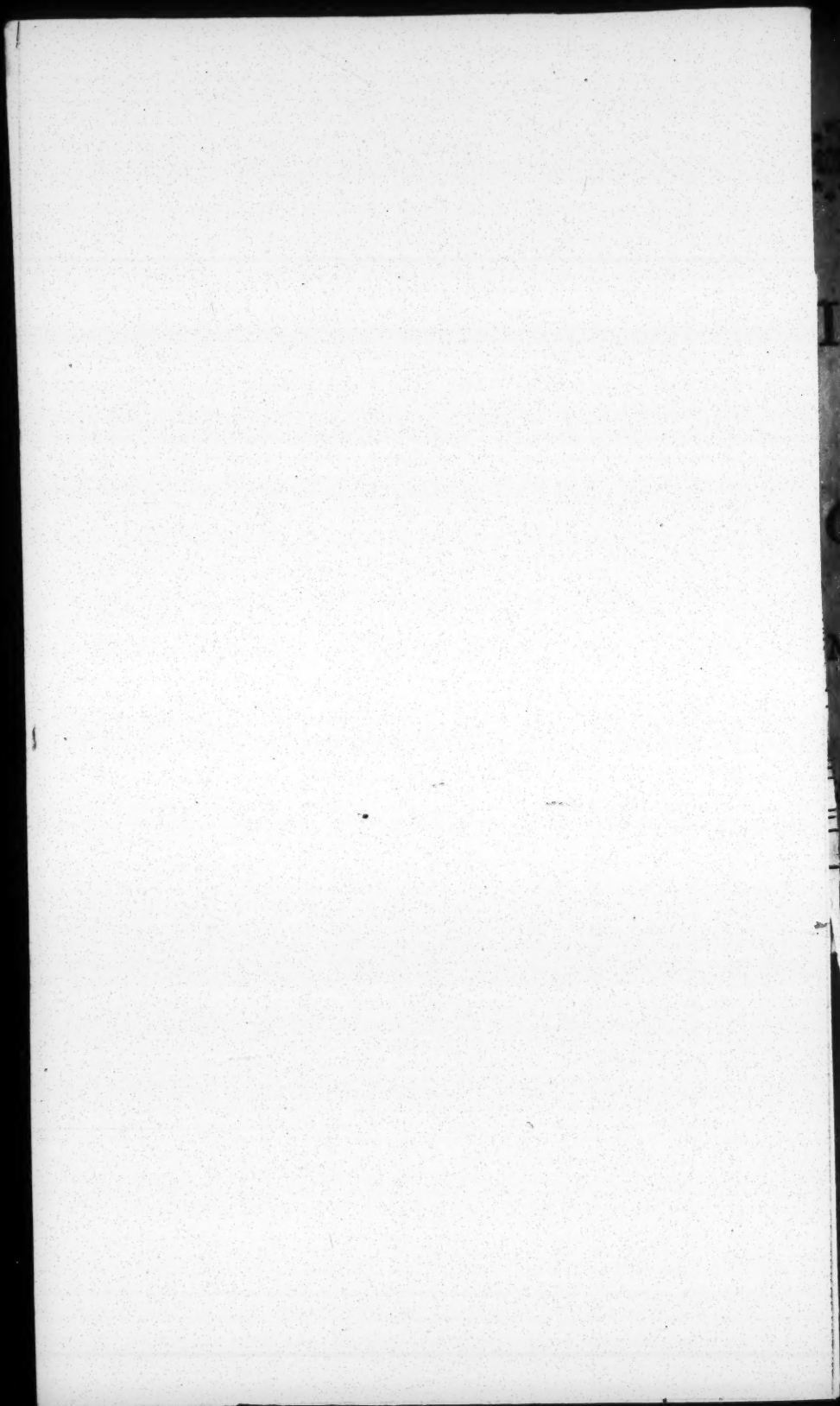
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A Necessary

INTRODUCTION;

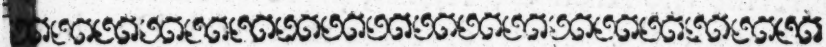
Consisting of

PROBLEMS and DEFINITIONS

Geometrical and Astronomical:

FOR THE

More easy apprehending, and ready Performing
of the several Matters and Things contain'd in
the following T R E A T I S E.



PROP. I. FIG. I.

Upon any Point (as O) taken in the Right-Line
QR, to erect a Perpendicular OS.



PEN your Compasses to any small
Distance ; and setting one Foot in
the given Point O, with the other
Foot makes Marks on both the sides
O, as at T and V.

2. Open the Compasses to any Distance, grea-
ter than the former, and setting one Foot in T,
with the other describe the Arch *bb*: Also, with
B the

the same Distance, set one Foot in V, and with the other describe the Arch *gg*, crossing the former Arch *bb* in the Point S.

3. Draw the Line OS, and it will be *Perpendicular* to the given Line QR.

PROB. II. FIG. II.

A Right-Line given, how to draw another Right-Line, which shall be Parallel thereunto at any Distance required.

1. **L**ET the Line given be AB, unto which is required to draw another Right-Line CD, which shall be Parallel to the former Line AB, and at the Distance AC.

1. Open your Compasses to the Distance AC, then set one Foot in the Point A, with the other describe the Arch C; Again, place one Foot in B, and with the other describe the Arch D; then draw the Line CD so that it may only touch the two Arches C and D, so shall the Line CD so drawn, be Parallel to AB, and at the Distance required.

Astronomical Definitions.

THE Horizon is that part of the Heavens as a quick Eye can discern in an open Place; which divides the Heavens into two equal Parts. The middle Point of the Heavens which is over our Heads, is called the *Zenith*; and that under our Feet the *Nadir*.

2. The

2. The *Meridian* is a great Circle of the Heavens, passing through the Poles; the *Zenith* and *Nadir*, in which the Sun is at Noon, and at Twelve a Clock at Night.

3. The *Equinoctial* is a great Circle of the Heavens, dividing it into the Northern and Southern Hemispheres; and takes their Names from the two Poles, that being call'd the *Northern Hemisphere*, in which the *North-Pole* is seated; and that the *Southern* in which the *South-Pole* is seated. Unto this Circle when the Sun in his Annual Motion arriveth, (which is twice a Year) the Days and Nights are of an equal length through the whole World.

This Circle cutteth the *Axis* of the World at Right Angles, and is seated in the Heavens every ways 90 deg. distant from either of the *Poles*.

4. The two Topicks are *Smaller Circles* of the Heavens, described parallel to the *Equinoctial* Circle, and at 23 deg. 30 min. distance therefrom; so that being the greatest *Declination* that the Sun hath from the *Equinoctial* towards either of the *Poles*. Of these Circles one is called the *Tropick of Cancer*, or Northern Tropick; the other the *Tropick of Capricorn*, or Southern Tropick. These two Circles are the Bounds or Limits of the Sun's Course, for between them he always moveth, never going more Northward or Southward, (that is, declines not nearer to any of the Poles) than 23 deg. 30 min. Wherefore, when the Sun in his Annual Motion, shall arrive to the *Tropick of Cancer*, which is about the 10th or 11th of June he maketh the longest *Days* to all inhabit the

Northern Hemisphere. And when he arriveth to the *Tropick of Capricorn*, which is about the 11th of *December*, he maketh the shortest *Days* to those that inhabit the Northern, and the longest to those of the Southern Hemisphere.

How to find a True Meridian-line; and the Azimuth of the Sun.

IT is very necessary to have a true *Meridian-line*, which may be obtained many ways, but the best I know for Practice is this;

Get a plain thick Board of a Foot Square, or more, then in the middle, or as near as may be, fasten a strong Iron Pin, about three Inches long, and make it so fast, that it will not shake or yield in the least: It matters not whether it be exactly Perpendicular, or not.

Set this Board Horizontally, with Earth or Sand upon the Ground; about Nine a Clock see where the Head of this Iron-pin (which must be sharp at top) giveth its Shadow upon the Board, mark that Place: Then take a wooden Ruler, sharp also at the end, and lay it so, upon the sharp end of the Iron-Pin, that the sharp end of the Ruler, may touch the Mark, then carrying it steady, describe a Circle.

Come again about Three a Clock in the Afternoon, and mark where the Shadow of the Top of the Iron-Pin is in that Circle again.

Draw a Line from those two Marks, which will be *East* and *West*, and the Perpendicular to that Line will be a true Meridian-Line. But

But because the Sun may be under a Cloud, when you come at three a Clock, you may make three or four more Circles, and use them as you used this.

When you have a true *Meridian-Line*, you will easily find the Sun's *Azimuth*, or Distance from the *South*; for hold but up a Plumb-line, and the Angle which the Shadow maketh with the *Meridian-Line* is the *Azimuth*; or you may lay the Edge of your *Quadrant* to the *Meridian-line*, and the Shadow of the Plumb-line passing through the Center, will give you the *Azimuth* in the Limb, and better than if you Calculated it by the Sun's *Altitude*.

How to make a Line of Chords to any Length or Radius.

First make a Right-line of any length as CBD, and upon the middle, by the first Problem, erect the Perpendicular AB.

Secondly, Open your Compasses to the Radius, or Length, that you would have your Line of Chords to be of, which suppose AB, and with that distance upon B, describe the Semicircle CAD.

Thirdly, Your Compasses being open to the same distance you describ'd the Semicircle, set one Foot in D, and make a mark in the Quadrant DA, as at R, then take with Compasses the distance on the Quadrant, from A to R, and set from R to S, so the Quadrant will be divided into 30, 60, 90, deg.

deg. then divide DS, and SR, and RA, each into three Parts, which will be 10, 20, 30, 40, 50, 60, 70, 80 and 90.

Lastly, Set your Compasses in D, and open them to every one of the Nine Parts that the Quadrant is divided into by 10, 20, &c. and describe the prick'd Line as you see in the Figure.

Note: You may divide the Quadrant AD, if you will, into 90 equal Parts, if your Quadrant is large, and so transfer them from the Quadrant to the Line CBD, as you did by every ten Degrees.

PROB. III. FIG. III.

The Latitude of the Place, the Declination of the Sun, and the Altitude of the Sun being given, to find out the Azimuth, Geometrically.

	deg. min.	
The Latitude of the Place is	}	North
The Declination of the Sun is		
The Altitude of the Sun is		

I. Upon the Center Q. describe the Semicircle HZO for half the Meridian, and upon Q, raise the Perpendicular QZ, for the Zenith.

II. Set 51 deg. 30 min. of your Line of Chords, which is the Latitude of London, from Z to Æ, and draw ÆQ from the Equinoctial.

III. Set 20 deg. 9 min. the Sun's Declination, from Æ towards Z, to the Point D, (being it is North) and draw the Line DT parallel to ÆQ, so is DBT the *Parallel of the Sun's Declination*.

IV. Set 18 deg. 2 min. the Sun's Altitude given, from

from O to L, and from H to M, and draw the Line ML, for the *Parallel of Altitude*.

V. Take your Compasses, half the length of the *Parallel of Altitude* SL, or SM; and with that Distance upon Q, describe the innermost Semicircle ACG.

VI. From the Point B, which is where the *Parallel of Delination*, and the *Parallel of Altitude* do intersect, erect the *Perpendicular* BC, till it touch the innermost Semicircle.

VII. Lay a Ruler from Q to C, and it will cut the outermost Circle in E; so HE measured upon a Line of Chords be 80 deg. the Sun's *Azimuth* from the North part of the *Meridian*.

VIII. EZ shall be 10 deg. the *Azimuth* from the East or West.

IX. Lastly, EQ shall be 100 deg. the *Azimuth* from the South part of the *Meridian*.

Note: And whereas throughout this Book there is continual mention made of *Degrees* and *Minutes*; know, that a Degree is the 360th part of any Circle, each of which Degrees is supposed to be divided into 60 Parts called Minutes, so that 45 Min. is three quarters of a Degree, 30 Min. half a Degree, and 15 Min. one quarter of a Degree, &c.



A Table of the Sun's Declination.

Days.	January		Februa.		March		April		May		June	
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.
1	21	44	13	46	3	24	8	36	18	5	23	12
2	21	33	13	26	3	0	8	58	18	20	23	16
3	21	23	13	5	2	37	9	20	18	35	23	19
4	21	13	12	45	2	13	9	42	18	50	23	22
5	21	2	12	25	1	49	10	3	19	4	23	25
6	20	50	12	3	1	25	10	24	19	18	23	27
7	20	38	11	43	1	1	10	45	19	31	23	29
8	20	26	11	21	0	38	11	0	19	44	23	30
9	20	13	11	0	0	14	11	27	19	57	23	31
10	20	0	10	38	0	10	11	47	20	10	23	32
11	19	46	10	16	0	33	12	7	20	22	23	31
12	19	32	9	54	0	57	12	28	20	34	23	31
13	19	18	9	32	1	21	12	48	20	45	23	30
14	19	3	9	10	1	44	13	7	20	56	23	29
15	18	48	8	48	2	8	13	27	21	7	23	28
16	18	32	8	25	2	31	13	46	21	17	23	26
17	18	17	8	3	2	54	14	5	21	27	23	23
18	18	2	7	40	3	18	14	24	21	37	23	20
19	17	45	7	17	3	41	14	42	21	46	23	17
20	17	28	6	54	4	5	15	1	21	55	23	14
21	17	11	6	31	4	28	15	19	22	4	23	10
22	16	54	6	8	4	51	15	37	22	12	23	6
23	16	36	5	45	5	14	15	54	22	20	23	1
24	16	18	5	21	5	37	16	12	22	27	22	55
25	16	0	4	58	6	0	16	29	22	34	22	50
26	15	42	4	34	6	22	16	46	22	41	22	44
27	15	23	4	11	6	45	17	2	22	47	22	37
28	15	4	3	47	7	7	17	18	22	53	22	31
29	14	45	3	39	7	30	17	34	22	59	22	23
30	14	26			7	52	17	50	23	3	22	16
31	14	6			8	14		23		8		

A Table of the Sun's Declination.

Days.	July		August.		Septem.		October.		Novem.		Decem.	
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.
1	22	8	15	12	4	24	7	15	17	40	23	9
2	22	0	14	55	4	2	7	38	17	56	23	13
3	21	51	14	36	3	38	8	0	18	12	23	17
4	21	42	14	17	3	15	8	22	18	28	23	20
5	21	32	13	58	2	52	8	45	18	43	23	23
6	21	22	13	39	2	29	9	7	18	58	23	26
7	21	12	13	20	2	5	9	29	19	13	23	28
8	21	2	13	1	1	42	9	51	19	27	23	30
9	20	51	12	41	1	19	10	13	19	41	23	31
10	20	40	12	21	0	55	10	33	19	55	23	31
11	20	28	12	1	0	32	10	56	20	8	23	31
12	20	16	11	41	0	8	11	18	20	21	23	31
13	20	4	11	21	0	16	11	39	20	34	23	29
14	19	51	11	0	0	39	12	0	20	46	23	27
15	19	38	10	39	1	3	12	21	20	58	23	25
16	19	25	10	18	1	26	12	41	21	9	23	22
17	19	12	9	57	1	50	13	2	21	20	23	19
18	18	58	9	36	2	13	13	22	21	31	23	16
19	18	43	9	15	2	37	13	42	21	41	23	12
20	18	23	8	53	3	0	14	2	21	50	23	7
21	18	14	8	31	3	25	14	21	22	0	23	2
22	17	59	8	9	3	47	14	41	22	9	23	0
23	17	44	7	47	4	10	15	0	22	15	22	57
24	17	28	7	25	4	33	15	19	22	17	22	51
25	17	12	7	3	4	57	15	37	22	33	22	44
26	16	56	6	41	5	20	15	55	22	40	22	27
27	16	39	6	18	5	46	16	1	22	46	22	30
28	16	22	5	56	6	6	16	3	22	52	22	22
29	16	6	5	33	6	29	16	49	22	58	22	15
30	15	48	5	10	6	52	17	6	23	4	22	5
31	15	30	4	47			17	28		22	56	

The End of the Introduction.



How to find the Situation of any Plane, from the South or North, towards either East or West; commonly called the Declination of Plane.

THE Declination of a Plane, is an Arch of the Horizon comprehended between the Pole of the Plane, and the Meridian of the Place. Or it is the distance of the Plane itself, from the prime Verticle Circle, or Azimuth of East and West.

To find out the Declination of any Plane, there are required two Observations to be made by the Sun at the same instant of time. The first of the Sun's Horizontal distance from the Pole of the Plane and secondly, of the Altitude of the Sun.

First, To find the Sun's Horizontal Distance from the Pole of the Plane. Apply one edge of a Quadrant, to the Horizontal-Line of your Plane so that the other may be Perpendicular to it, and the Limb of the Quadrant must be towards the Sun, and hold the whole Quadrant Horizontal as near as you can conjecture: Then holding up a Thread and Plummets, at full Liberty, so that the Shadow of the Thread, may pass both thro the Center and Limb of the Quadrant, observe then the Degrees cut by the Shadow of the Thread, and number them from that side of the Quadrant that standeth square or Perpendicular to

the

the Plane : For those Degrees are the *Horizontal Distance* required.

Secondly, This *Horizontal Distance* and the *Sun's Altitude* being observed at the same time (as near as may be) will help you to the *Planes Declination* in this manner.

When you make your Observation, of the *Sun's Horizontal Distance*, mark whether the Shadow of the Thread, fall between the *South*, and that side of the Quadrant which is Perpendicular to the Plane.

I. If the Shadow fall between them, the *Azimuth* and *Distance* added together, do make the *Declination of the Plane*, and in this Case the *Declination* is upon the *same Coast* whereon the *Sun's Azimuth* is.

II. If the Shadow fall not between them, subtract the lesser of them from the greater, and the remainder shall be the *Plane's Declination*; and if the *Azimuth* be the greater of the two, the Plane Declines to the *same Coast* whereon the Sun is, but if the *Distance* be the greater, then the Plane Declines to the contrary Coast.

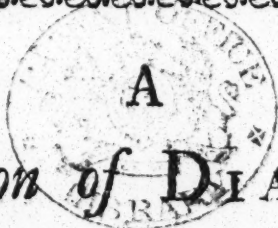
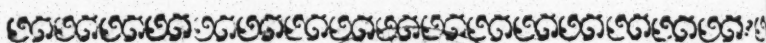
And here Note, That the *Declination* thus found is always accounted from the *South*, and that all *Declinations* are counted from either *South* or *North*, towards either *East* or *West*, and must never exceed 90 Degrees.

I. If therefore the degrees of *Declination* do exceed 90, you must take the residue of that Number to 180, and that shall be the *Plane's Declination* from the *North*.

II. IF

II. If the Degrees of Declination exceed 180 deg. then the excess above 180 deg. gives the *Plane's Declination* from the *North* towards the *Coast*, which is contrary to the *Coast* where the *Sun* is.

But seeing the Declination is the Angle contained between the Perpendicular from the *Wa* and the *Meridian*, it may be the best to wait in fair *Weather*, till you find the *Sun* in the *Meridian*, and then the Angle upon the Limb of the *Quadrant*, will itself be the Declination.



Description of DIALLING

DIALLING is an Art teaching how to Measure the time of the Day, by the shadow of the *Sun*; and originally is a *Mathematical Science*, attained by the Philosophical contemplation of the motion of the *Sun*, the motion of the *Shadow*, the Constitution of the *Sphere*, the Situation of *Planes*, and the consideration of *Lines*.

The motion of the *Sun* is regular, in moving equal Space in equal Time; but the motion of the *Shadow* irregular in all parts of the Earth, unless under the two Poles, and that more or less according to the Constitution of the *Sphere*, and the Situation of the *Plane*.

And therefore by Art there is found out Rules to mark out the irregular Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the regular Motion of the Sun. And these Rules of adjusting the Motion of the *Shadow* to the motion of the Sun, may be called the Art of *Shadows*.

Of the several Sorts of Planes upon which
DIALS are usually made.

Definitions.

A *Dial Plane* is that Flat whereon a Dial is intended to be made.

Of *Dial-Planes* some be *Direct*, others *Decliners*, and others *Oblique*.

Of *Direct Planes* there are five sorts.

1. The *Horizontal* whose Plane lies flat, and is parallel to the *Horizon*, beholding the *Zenith*.
2. The *South Erect*, whose Plane stands upright, and directly beholds the *South*.
3. The *North Erect*, whose Plane stands upright, and directly beholds the *North*.
4. The *East Erect*, whose Plane stands upright, and directly beholds the *East*.
5. The *West Erect*, whose Plane stands upright, and directly beholds the *West*.

Of *Decliners* there are infinite; and yet may be reduced into these two *Kinds*.

1. The *South Erect Plane*, declining more or less towards the *East* or *West*.

2. The

2. The *North Erect* Plane, declining more or less towards the *East* or *West*.

Of *Oblique Planes* some are *Direct*, others *Declining*. Now an *Oblique* Plane is (as to explain it to a mean Capacity) a Plain, or Dial which falls or leaneth from you like the Roof of a House, and are of these Kinds:

1. The *Direct South-Dial* Reclining.
2. The *Direct North-Dial* Reclining.
3. The *Direct East* or *West* Reclining.
4. The *North* and *South* Declining Reclining Dials.

Note 1. That all Angles are usually measured by a Line of Chords, whose *Radius* or *Semi-diameter* is equal to the Chord of 60 deg. and do contain 90 deg. which is a Quadrant; sometimes by a Tangent-line.

2. If the Hours of a Dial be never so truly drawn, if the Stile be not well plac'd, it will not go exact; therefore observe these three Rules in setting your Stile.

1. That it has the same Center (if there be any) with the Substile and Hours.
2. Its due Angle.
3. That it stands perpendicular to the Substile

(15)

THE

Art of SHADOWS:

OR,
TABLES, &c.

CHAP. I. FIG. IV.

How to draw an Horizontal Dial.

DR A W the Line AB, for 6 and 6 Morning and Evening.

2. Draw NS, perpendicular to AB ; this shall be the 12 a Clock Hour-line.

3. Let C, the Intersection of the foresaid Lines be the Center of the Dial, then take in your Compasses 60 deg. of a Line of Chords, and with that Distance upon the Center C draw an obscure Segment of a Circle, as AmB.

4. Turn to your Table of Horizontal Spaces, and see what Degrees and Minutes answer to 11 and 1 a Clock ; you find they are 11 deg. 51 min. take therefore 11 deg. 51 min. out of your Line of Chords, and set it from *m* to *bb*, on both sides the 12 a Clock Line.

Likewise take 24 Deg. 20 Min. for 10 and 2 a Clock, and set it from *m* to *bb*. Take 38 deg. 1 min. and set it from *m* to *cc* ; work after the same manner for the remaining Hours.

5. From

5. From the Center *C*, thro' each of the Points *a*, *b*, *c*, *d*, *e*, draw Lines, which shall be the Hours required. The intermedial Spaces, viz. Quarters, Half, and three Quarters of an Hour are drawn after the same Method.

Lastly, The Stile of your Dial must always make an Angle equal to the *Latitude* of the Place. Take therefore 51 deg. 30 min. out of your Line of Chords and set it from *m* to *n*, thro' *C* and draw the Line *Cn*.

Note 1. That the Stile must stand at Right Angles with the *Plane* upon the 12 a Clock-Line.

2. That the 12 a Clock Line must be set exactly *North* and *South*.

3. That the whole *Plane* must be laid parallel to the *Horizon*.

4. That the 2 Hours above the Line of 6, are drawn by extending the two opposite Hour-lines thro' the Center, as 4 in the Morning is drawn by extending 4 in the Afternoon, &c.

CHAP. II. FIG. V.

How to draw the Hour-lines upon a Direct South-Dial.

THERE is little Difference between describing a *South-Dial* and an *Horizontal-Dial*, only Observe,

1. That the Angle which every Hour-line makes with the *Meridian* must be taken from the Table of *South-Dial Spaces*, and prick'd down on

the Segment of the Circle A, B, m, as before directed in the *Horizontal Dial*.

2. That the Angle which the Stile makes with the *Meridian* must be 38 deg. 30 min. always the Complement of your *Latitude*.

Note; That the Stile must stand at Right Angles with the Plane.

2. That the Face of the Dial must look exactly South, and be placed perpendicular to the *Horizon*.

C H A P. III.

Fig. 6.

How to draw the Hour-lines upon a Direct North Dial.

A *Direct North Dial*, is the same with a *Direct South Dial*; for, if you take a *South-Dial* and turn it upside down, causing the Stile to point upwards, as the Stile of the *South* doth point downwards, and leaving out the Hours near the *Meridian*, in these *Northern Latitudes*: as the Hours of 9, 10, 11, and 12 at Night, and 1, 2, and 3 in the Morning, all which time the Sun is under the *Horizon*. I say a *South-Dial* so inverted, and fixed against a direct *North Wall*, shall give the true Hour of the Day.

C H A P. IV.

Fig. 7.

How to draw the Hour-lines upon a Direct, East or West Dial.

UPON the point C, if it be an *East-Dial*, or upon the point D, if a *West*, with 60 deg. of your line of Chords draw an obscure Segment of

of a Circle EF; then take 38 deg. 30. min. the Complement of your *Latitude*, and set it from E to F, and draw CF thro' the Plane. Call this Line the *Equinoctial*.

2. Assume any two points in this *Equinoctial* at a convenient distance for the Hour-lines of 12, 11, and 6; and thro' these points GH, draw *Perpendiculars* to the *Equinoctial*.

3. On G with 60 deg. of your Line of Chords describe an obscure Arch of a Circle IK, and set thereon 14 deg. from I to K, and draw the Line GK, to cut the Hour-line of 6 in the Point L. So shall LH be the Height of the *perpendicular* Stile porportioned to this Plane.

4. Upon L with 60 deg. of Chords, describe an Arch of a Circle M, N: between the Hour-line 6 and GL. Divide the Arch MN, into five equal parts with 15 deg. of Chords. Then turn to your Table for *East* and *West Dials*, and see what number stands against each hour, (and the *Intermediate Spaces*, if you please to put them in) take the said numbers out of your Line of Chords and put them upon the Arch MN, from M to N.

5. Lay a Rule from L to each of the Divisions, &c, and where the Rule intersects the *Equinoctial*-line, make marks ***, &c. Lines drawn thro' these points ***, &c. Parallel to the Hour-line of 6, shall be the true Hour-lines for an *East-Dial* from 6 to 11; but if you transfer the same distances on the *Equinoctial* before 6, as there is after 6, and thro' these distances draw lines parallel to 6; you have also the hour before 6, as 5, 4, &c.

Note; 1. That the Stile may be a plate of Brass or

an. the Iron of the same breadth as is the distance between 6 and 9 on the *Equinoctial*, and fixed upon the line of 6, perpendicular to the Plane.

2. That an *East* and *West Dial* is the same in *Equinoctial* Respects, save that the hour-lines of 4, 5, 6, 7, of 11, in the Morning in the *East Dial*, must be 8, 7, 6, 5, 4, in the Evening on the *West Dial*.

C H A P. V.

Fig. 8.

How to draw the Hour-lines upon South or North Planes, Declining either East or West, 30 deg.

DR A W the Line NS for 12 a Clock Hour-line.

2. In this Line choose a Center as C, upon which with 60 degrees of Chords, describe an obscure Circle.

3. Turn to your Table of *Requisites*, and see what is the Substiles distance for 30 Degrees of Declination; 'Tis 21 deg. 40 min. take the said distance out of your Line of Chords, and set it from M to S: thro' C and S draw an obscure line for the Substile.

4. Now turn to your *Declination* in the Tables to the *Hour distances* for the Substile, and see what Numbers stands against each Hour (and $\frac{1}{4}$ part let you would insert them in your Dial) transfer these numbers by help of your Line of Chords to the Circle from S, towards AB; and thro' those Points draw Lines from C, the Center of your Dial; these are the Hours required.

5. And Lastly, In your Table of *Requisites*, under the Stiles height, and opposite to 30 deg. Declination, you'll find 32 deg. 37 min. Set

C 2

this

this distance from S to T, then draw C T, and you have the height of the Stile or Gnomon.

Note 1. That the larger the Radius of your Line of Chords is, the better you may infer the Hour-lines.

2. If the Declination be *East*, the Substile must be placed on the left side of the *Meridian*: and those hours that are next to the numbers in your Table must be used: But the contrary, if the Declination be *West*.

3. If the Face of your Dial be towards the *North*, you must turn the Dial the Bottom upwards; and reckon the Hours the contrary way. So a *South East Decliner* will be a *North East Decliner*, and a *South West Decliner*, will be a *North West Decliner* leaving out the Hour-lines, (which will be needless) before Sun-setting, and after Sun-rising.

4. That the Stile must be fix'd upon the Substile, and stand at Right Angles with the *Plane*.

C H A P. VI.

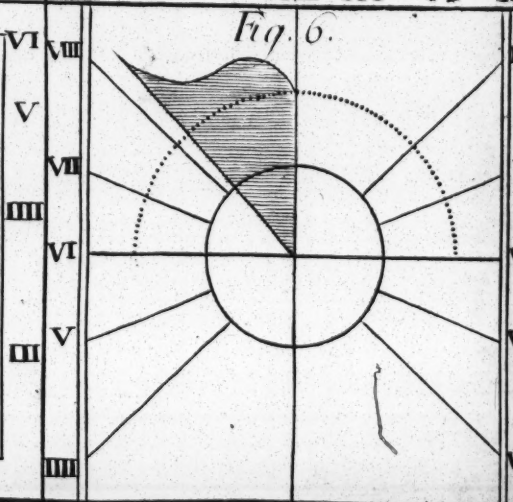
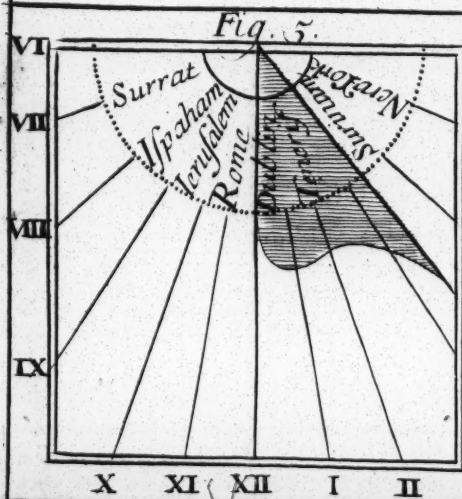
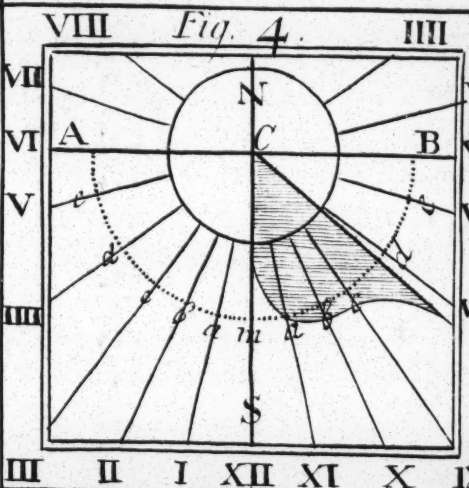
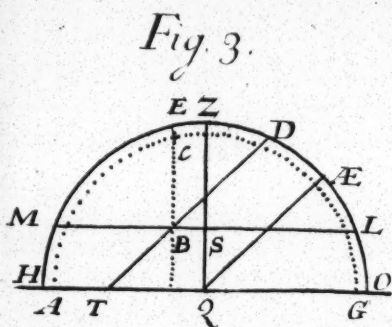
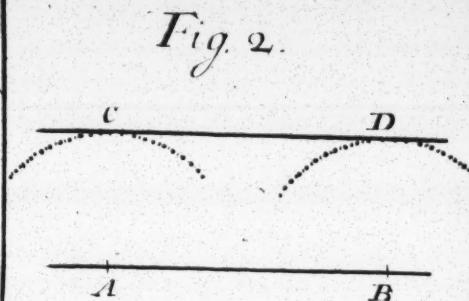
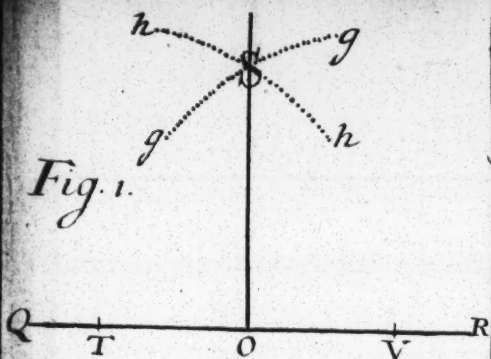
Fig.

How to draw the Hour-lines upon an Equinoctial Plane.

1. **D**R A W the Right Line AB, for the Horizontal Line of the Plane, and cross about the middle thereof at Right Angles, with a Line 12 Q 12, for the Meridian and Hour-line of 12.

1. Upon the Line 12 Q 12, either above or below Q, assume any Point at S, and setting one foot of your Compasses therein, (it being open

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to the Radius of your Line of Chords) describe the Circle CDE, which divide into 12 equal parts, beginning at D.

3. Lay a Rule to S, and the several Points $\odot\odot\odot$, &c. and it will cut the Line AB, in the Points $***$, &c.

Lastly, Through these Points $***$, &c. draw Right Lines all parallel to the Line 12 Q 12, and so your Dial is finished.

The Stile may be either a streight Pin, of the length of the Line QS, and set perpendicular to the Plane, upon the point Q; the shadow of the Top thereof only giving the Hour.

Or it may be a plate of Brass or Iron, of the breadth of the distance that is between the Hour-line of 12 and 3, or 12 and 9. And then will the shadow of the upper edge thereof give the true Hour of the Day.

C H A P. VII.

Fig. 10.

How to draw the Hour-lines upon a Direct Polar Plane.

1. **D**EScribe the Circle ABDE, with 60 deg. of your Line of Chords.

2. Draw the Diameters AC and AD at Right Angles, in the Center O. AC shall be the hour of 12, and BD the hour of 6.

3. Turn to your Table of *Polar Dial*, and see what numbers answer to every hour, take the said Numbers from your Line of Chords, and prick them down in the Circle ABCD, on both sides the 12 a Clock-line; Draw lines from these points thro' the Center O, and your work is done.

Note 1. That this *Plane*, by reason of its *North Reclination*, is in Summer, capable of receiving all the Hours from Sun-rising to Sun-setting, and therefore the Hour-lines of 4 and 5 in the Morning, and of 7 and 8 at Night, must be drawn through the Center, as you did in the *Horizontal Dial*.

2. That the Hour-line of 12 must stand exactly *North* and *South*.

3. That the *Plane* must be elevated the same number of Degrees towards the *South*, as the *Equator* is in your *Latitude*.

4. The *Stile* must be a streight Pin or Wire, (set perpendicular to the *Plane*, from the Center O) of any length.

5. The *South inclining Plane* opposite to this, is directly the same, only the Forenoon hours in this must be the Afternoon in that, and the hours of 4 and 5 in the Morning, and of 7 and 8 in the Evening, must be omitted.

C H A P. VIII.

Fig. II.

How to draw the Hour-lines upon Far-Declining Dials.

BEcause the Tables extend no farther than 60 deg. of Declination, (and if they had been Calculated to 90 deg. they would have been of little use, because the *Stile's* height being so small, the Hour lines would have been of no Competent Distance) and because many times there may be Occasion to make a Dial for a greater Declination, I will shew a Geometrical way to draw

draw such, by the help of a Line of Chords only.

Let the Declination given be 80 deg. Eastwards.

1. Draw a Line BC, perpendicular to the *Horizon* of the *Plane*.

2. Upon C, with a Chord of 60 deg. describe the Arch QS, then out of the Table of *Requisites* take the Substile's distance, and set it from Q to N; take also the Stile's height, and set it from N to b.

3. Draw CD for the Substile, and CE for the Stile: Then at any convenient distance draw KL parallel to CE the Stile. Also assume any two points in the Substile, and thro' them draw the Perpendiculars FG, and HI.

4. Take the nearest distance from T to KL, and from V to KL, and set it from T to R, and from V. to D.

5. Upon D and R, with 60 deg. of Chords, describe two Arches of a Circle, and set off the Inclination of the *Meridian* from T to P, and from V to O. With 15 deg. of Chords divide the Segments into equal parts, beginning at O and P.

6. Lay a Rule on D, and on each division in the Arch VO, and mark the Intersection of the Rule with the Line FG. Then lay the Rule to R, and work after the same manner in other Arch, and HI.

7. Thro' the marks made in HI, and GF, draw the Hour-lines.

Note 1. When the *Plane* declines *Westward*, the perpendicular CB must be put on the *Right-hand*.

2. That the Inclination of the *Meridian* must be set on the same side of the Substile with the Perpendicular.

Thus have you finished your Dial, and in the making of this you have made a *South* declining *West* 80 deg. also; for if you turn the paper, and look through it, it will on the back-side be a *South* declining *West* 80 deg. only the Forenoon hours in this, must be Afternoon in that: Nay, of right you have made in this one Dial Four, viz. a *North*, declining either *East* or *West*, if you well observe what was said of the Dial declining 30 deg.

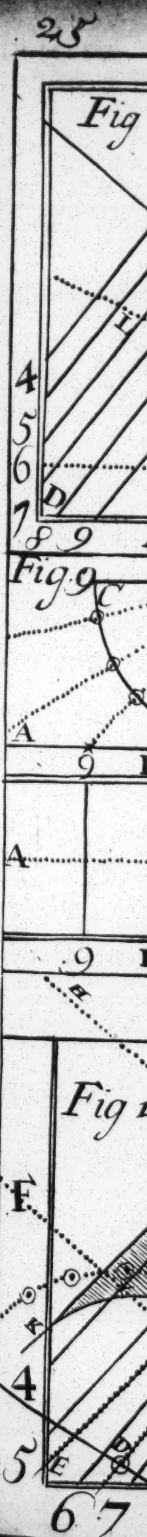
C H A P. IX.

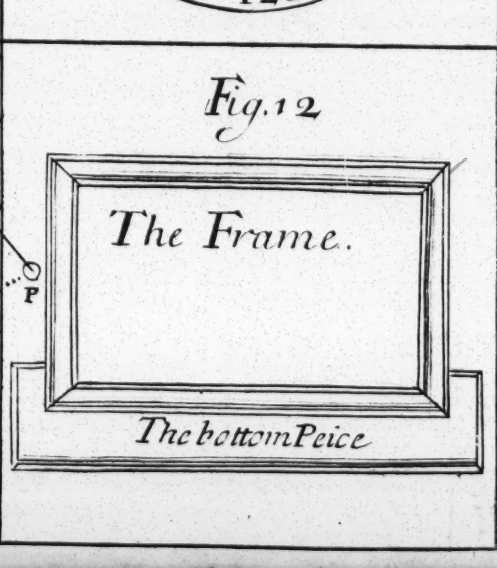
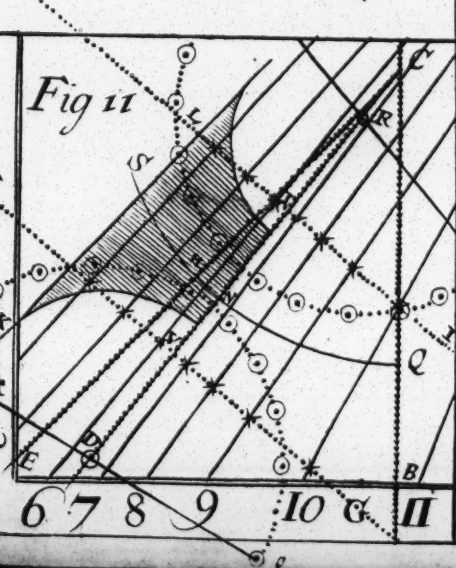
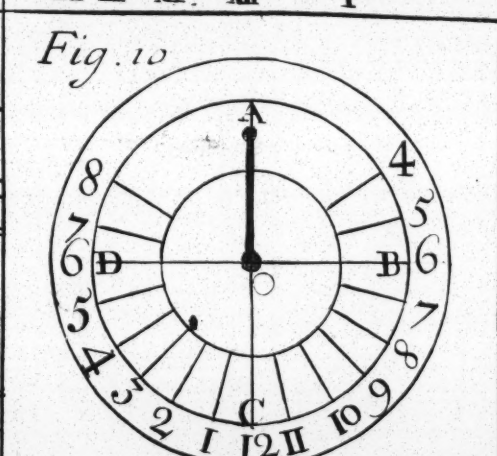
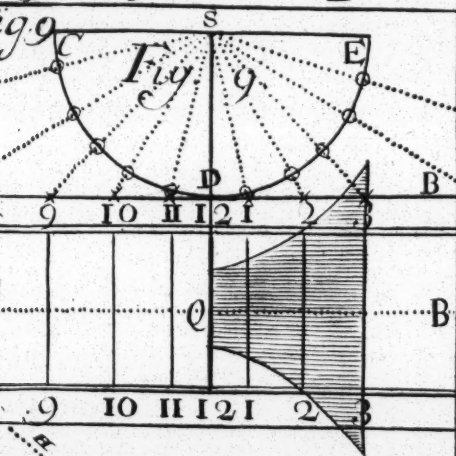
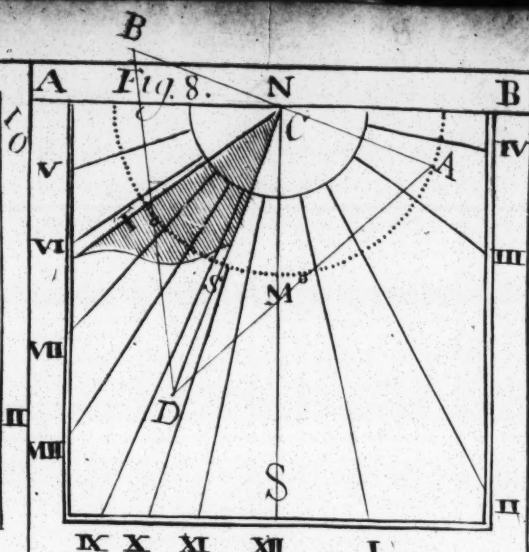
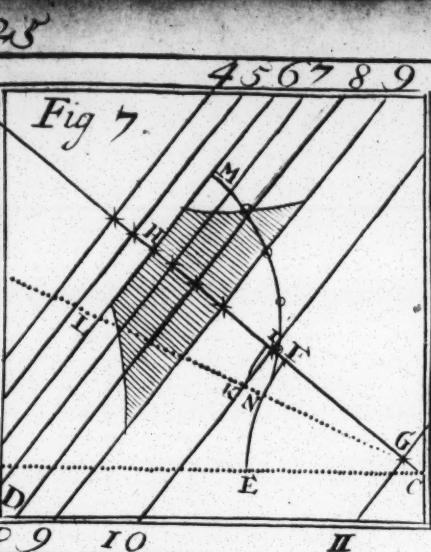
How to place an Upright Dial truly.

ALL *Upright Dials*, in what Latitude soever, have the *Meridian* perpendicular to the *Horizon*, Therefore set your Dial exact, hang a Line with a Plummert at the end thereof, upon a Nail fixt in the Line of 12 toward the top; then apply your Dial to the Place where it is to be fixt, so that the Line and Plummert may hang just down upon the Line of 12: The Dial thus fixt (if the Declination be truly taken, and the Dial made by the former directions) will at all times (if the *Sun's* on it) give the true Hour of the Day.

Note. In every Dial truly placed, if you stand on the *South-side* of the Plane looking *Northward*, the Hours on your *Left-hand* of the *Meridian*, are the *Morning-Hours*, on your *Right-hand* are the *Evening-Hours*; but if you stand on the *North-side* of the Plane, your Face being *Southward*, then the *Forenoon-Hours* are on your *Right-hand*, and the *Afternoon-hours* on your *Left-hand*; because your *Right-hand*, in relation to the Plane, is where your *Left-hand* was.

The





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Declination.

1
2
3
4
5
6
7
8
9
0
1
2
3
4
5
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7
8
9
0
1

The Three Requisites in Dialling, Calculated to every Degree of Declination, in the Latitude 51 deg. 30 min.

Declination.	Sub- stile's Di- stance Meri- dian.		Stile's height.		Incli- nation of Me- ridian.		Declination.	Sub- stile's Di- stance Meri- dian.		Stile's height.		Incli- nation of Me- ridian.	
	d.	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m.
1	00	48	38	29	1	17	22	16	36	35	16	25	18
2	1	36	38	28	1	33	23	17	16	34	57	28	39
3	2	23	38	26	3	49	24	17	56	34	39	29	38
4	3	11	38	23	5	07	25	18	37	34	21	30	47
5	3	58	38	20	6	23	26	19	13	34	01	31	56
6	4	45	38	15	7	39	27	19	50	33	42	33	04
7	5	32	38	10	8	55	28	20	29	34	20	34	12
8	6	19	38	04	10	11	29	21	05	32	59	35	19
9	7	05	37	57	11	27	30	21	40	32	37	36	25
0	7	52	37	49	12	42	31	22	15	32	15	37	31
1	8	38	37	40	13	57	32	22	50	31	52	38	36
2	9	23	37	30	15	10	33	23	25	31	27	39	41
3	10	08	37	21	16	26	34	23	59	31	04	40	46
4	10	54	37	10	17	40	35	24	31	30	40	41	49
5	11	38	36	58	18	54	36	25	04	30	14	42	52
6	12	22	36	43	20	07	37	25	35	29	48	43	55
7	13	05	36	32	21	20	38	26	04	29	22	44	58
8	13	49	36	18	22	33	39	26	35	28	56	45	59
9	14	31	36	03	23	45	40	27	03	28	29	47	00
0	15	13	35	48	24	57	41	27	33	28	01	48	00
1	15	54	35	31	26	08	42	28	01	27	33	49	00

The Three Requisites in Dialling, Calculated to every Degree of Declination, in the Latitude 51 deg. 30 min.

Declination.	Sub- stile's Di- stance Meridi- an.		Stile's height.		Incli- nation of Me- ridian.		Declination.	Sub- stile's Di- stance Meridi- an.		Stile's height.		Incli- nation of Me- ridian.	
	d.	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m.
43	28	29	27	05	50	00	67	36	13	14	05	71	3
44	28	55	26	36	50	59	68	36	25	13	29	72	2
45	29	21	26	07	51	57	69	35	36	12	53	73	1
46	29	46	25	37	52	55	70	36	46	12	18	74	0
47	30	11	25	07	53	55	71	36	55	11	41	74	5
48	30	35	24	38	54	50	72	37	06	11	06	75	4
49	30	38	24	06	55	46	73	37	15	10	29	76	3
50	31	21	23	35	56	42	74	37	24	09	53	77	2
51	31	45	23	04	57	38	75	37	32	09	16	78	0
52	32	05	32	32	58	33	76	37	40	08	40	78	8
53	32	26	22	00	59	28	77	37	47	08	03	79	4
54	32	46	21	28	60	23	78	37	57	07	27	80	3
55	33	06	20	55	61	17	79	37	59	06	49	81	2
56	33	24	20	22	62	10	80	38	04	06	12	82	0
57	33	42	19	49	63	04	81	38	09	05	35	82	9
58	34	00	19	16	63	57	82	38	14	04	58	83	7
59	34	15	18	42	64	49	83	38	17	04	20	84	5
60	34	33	18	06	65	41	84	38	21	03	44	85	3
61	34	47	17	34	66	33	85	38	23	03	06	86	1
62	35	05	17	00	67	24	86	38	26	02	28	86	0
63	35	18	16	25	68	16	87	38	28	01	52	87	9
64	35	34	15	50	69	07	88	38	29	01	15	88	7
65	35	43	15	15	69	57	89	38	29	00	37	89	5
66	36	00	14	40	70	47	90	38	30	00	00	90	4

A Table of Horizontal Spaces, shewing the Distance of each HOUR-LINE from the MERIDIAN upon DIRECT NORTH or SOUTH Planes, whether Erect, Reclining or Inclining: Calculated to every Degree of LATITUDE.

An Horizontal Dial, Latitude.	xi.		i. x.		ii.		ix.		iii.		viii.		iv.		vii.		v.		vi.		A Direct South Dial, Latitude.
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
1	0	16	0	34	1	0	1	0	1	44	3	44	90	00	39						39
2	0	32	1	9	2	0	3	27	7	25	90	00	38								38
3	0	48	1	44	3	0	5	11	11	3	90	00	87								87
4	1	5	2	19	4	0	6	54	14	36	90	00	86								86
5	1	20	2	52	4	5	8	35	18	1	90	00	85								85
6	1	36	3	27	5	5	8	10	16	21	19	90	00	84							84
7	1	52	4	3	6	5	7	11	55	24	27	90	00	83							83
8	2	8	4	37	7	5	5	13	33	27	23	90	00	82							82
9	2	23	5	9	8	5	4	15	10	30	17	90	00	81							81
10	2	40	5	43	9	5	1	16	44	32	57	90	00	80							80
11	2	55	6	17	10	4	8	18	17	35	27	90	00	79							79
12	3	11	6	51	11	4	5	19	48	37	49	90	00	78							78
13	3	27	7	24	12	4	1	21	17	40	1	90	00	77							77
14	3	43	7	57	13	3	6	22	44	42	4	90	00	76							76
15	3	58	8	30	14	3	1	24	9	44	0	90	00	75							75
16	4	13	9	2	15	2	5	25	31	45	49	90	00	74							74
17	4	29	9	35	16	2	6	26	52	47	26	90	00	73							73
18	4	44	10	8	17	1	0	28	9	49	4	90	00	72							72
19	4	59	10	39	18	2	29	25	50	33	90	00	71								71
20	5	14	11	10	18	5	30	39	51	55	90	00	70								70
21	5	29	11	41	19	4	4	31	50	53	9	90	00	69							69
22	5	44	12	13	20	3	2	32	58	54	21	90	00	68							68
23	5	59	12	43	21	2	0	34	5	55	30	90	00	67							67
24	6	13	13	13	22	8	3	35	10	56	37	90	00	66							66
25	6	28	13	43	22	5	5	36	12	57	34	90	00	65							65
26	6	42	14	12	23	4	0	37	13	58	34	90	00	64							64

A TABLE of *Horizontal Spaces, &c.*

An Horizontal Dial, Latitude.	xi. i.		x. ii.		ix. iii.		viii. iv.		vii. v.		vi.		A Direct South Dial, Latitude.
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
27	6	56	14	41	24	25	38	11	59	27	90	00	63
28	7	10	15	10	25	9	39	7	60	17	90	00	62
29	7	24	15	40	25	52	40	2	61	4	90	00	61
30	7	58	16	6	26	33	40	54	61	49	90	00	60
31	7	50	16	34	27	15	41	44	62	30	90	00	59
32	8	5	17	1	27	55	42	30	63	11	90	00	58
33	8	19	17	27	28	34	43	20	63	49	90	00	57
34	8	31	17	54	29	13	44	5	64	24	90	00	56
35	8	44	18	20	29	5	44	49	64	58	90	00	55
36	8	57	18	45	30	27	43	31	65	30	90	00	54
37	9	10	19	9	31	2	46	12	66	10	90	00	53
38	9	22	19	34	31	37	46	50	66	29	90	00	52
39	9	34	19	58	32	11	47	28	66	56	90	00	51
40	9	45	10	21	32	44	48	7	67	21	90	00	50
41	9	57	20	44	33	16	48	39	67	47	90	00	49
42	10	10	21	7	33	46	49	12	68	11	90	00	48
43	10	22	21	29	34	18	49	44	68	33	90	00	47
44	10	32	21	51	34	47	50	10	68	54	90	00	46
45	10	43	22	12	35	17	50	40	69	15	90	00	45
46	10	54	22	23	35	44	51	15	69	35	90	00	44
47	11	05	22	53	36	11	51	42	69	53	90	00	43
48	11	17	23	13	36	37	52	9	70	11	90	00	42
49	11	25	23	33	37	3	52	35	70	28	90	00	41
50	11	35	23	52	37	28	53	00	70	43	90	00	40
51	11	45	24	5	37	52	53	24	70	59	90	00	39
52	11	55	24	27	38	15	53	45	71	13	90	00	38
53	12	5	24	43	38	37	54	18	71	28	90	00	37
54	12	13	25	2	38	58	54	29	71	41	90	00	36
55	12	22	25	18	39	19	54	49	71	54	90	00	35
56	12	32	25	34	39	40	55	9	72	5	90	00	34
57	12	4	25	50	39	59	55	28	72	17	90	00	33
58	12	48	26	5	40	81	55	45	72	28	00	00	32

A TABLE of *Horizontal Spaces, &c.*

An Horizontal Dial, Latitude.	xi. i.		x. ii		ix. iii.		viii. iv		vii. v.		vi.		A Direct South Dial, Latitude.
	—		—		—		—		—		—		
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
59	12	46	26	20	40	36	56	3	72	38	90	00	31
60	13	4	26	34	40	54	56	19	72	48	30	00	30
61	13	11	26	47	41	10	56	34	72	58	90	00	29
62	13	19	27	1	41	21	56	49	73	7	90	00	28
63	13	26	27	13	41	42	57	3	73	15	90	00	27
64	13	32	27	25	41	57	57	17	73	24	90	00	26
65	13	39	27	37	42	15	57	30	73	32	90	00	25
66	13	46	27	49	42	25	57	43	73	39	90	00	24
67	13	51	27	59	42	38	57	54	73	46	90	00	23
68	13	57	28	9	42	50	58	5	73	53	90	00	22
69	14	3	28	19	43	2	58	16	73	59	90	00	21
70	14	8	28	29	33	13	58	26	74	05	90	00	20
71	14	13	28	27	43	18	58	35	74	11	90	00	19
72	14	18	28	46	43	24	58	44	74	16	90	00	18
73	14	22	28	54	43	36	58	52	74	20	90	00	17
74	14	27	29	2	43	52	59	00	74	25	90	00	16
75	14	30	29	7	44	00	59	7	74	30	90	00	15
76	14	33	29	15	44	8	59	15	74	34	90	00	14
77	14	37	29	21	44	14	59	22	74	37	90	00	13
78	14	41	29	27	44	22	59	27	74	41	90	00	12
79	14	44	29	32	44	28	59	32	74	44	90	00	11
80	14	47	29	37	44	34	59	37	74	47	90	00	10
81	14	49	29	41	44	37	59	40	74	49	90	00	9
82	14	51	29	45	44	40	59	44	74	51	50	00	8
83	14	53	29	49	44	44	59	47	73	53	90	00	7
84	14	55	29	52	44	48	59	51	74	55	90	00	6
85	14	56	29	54	44	53	59	54	74	57	90	00	5
86	14	57	29	55	44	55	59	55	74	58	90	00	4
87	14	58	29	56	44	56	59	56	74	58	90	00	3
88	14	59	29	57	44	57	59	58	74	59	90	00	2
89	14	59	29	58	44	58	59	59	74	59	90	00	1
90	15	00	30	00	45	00	60	00	75	00	90	00	

A Table of *Horizontal Spaces*, Exactly Calculated for the *Latitude* of *LONDON*: Shewing what *Angle*, every Five Minutes makes with the *Meridian*, upon an *Horizontal-Dial*.

<i>Hours.</i>	d.	m.	<i>Hours.</i>	d.	m.	<i>Hours.</i>	d.	m.
xii.	00	00	ii. x.	24	20	iv. viii.	53	36
5 55	00	59	5 55	25	25	5 55	54	59
10 30	1	58	10 50	26	30	10 50	56	23
15 55	2	57	15 45	27	37	15 45	57	48
20 40	3	55	20 40	28	44	20 40	59	14
25 35	4	54	25 35	29	51	25 35	60	40
30 30	5	53	30 30	30	59	30 30	62	10
35 25	6	53	35 25	32	00	35 25	63	35
40 20	7	32	40 20	33	18	40 20	65	4
45 15	8	51	45 15	34	29	45 15	66	34
50 10	9	51	50 10	35	40	50 10	68	4
55 5	10	51	55 5	36	51	55 5	69	35
i. xi.	11	51	iii. ix.	38	4	v. vii.	71	6
5 55	12	51	5 55	39	17	5 55	72	39
10 50	13	52	10 50	40	31	10 50	74	12
15 45	14	53	15 45	41	45	15 45	75	45
20 40	15	54	20 40	43	1	20 40	77	20
25 55	16	55	25 35	44	18	25 35	78	35
30 30	17	58	30 30	45	35	30 30	80	27
35 25	19	00	35 25	46	55	35 25	82	2
40 20	20	04	40 20	48	12	40 20	83	36
45 15	21	07	45 15	49	31	45 15	88	13
50 10	23	11	50 10	50	52	50 10	86	49
55 0	23	12	55 5	52	13	55 5	88	24
						vi. vi.	90	00

*A Table shewing
what Angle every
Hour, Quarters,
Halves, and
Three Quarters of
an Hour, makes
in a Direct
South-Dial.*

Hours.	d.	m.
xii.	00	00
1	3	2 21
2	2	4 41
3	1	7 4
xi.	9	28
1	3	11 57
2	2	14 28
3	1	17 4
x.	19	46
1	3	22 35
2	2	25 32
3	1	28 38
ix.	31	54
1	3	35 22
2	2	39 3
3	1	42 58
vi.	47	9
1	3	51 37
2	2	56 21
3	1	61 24
v.	66	43
1	3	72 17
2	2	78 3
3	1	83 59
vi.	90	

*A Table for East
and West-Dials.*

Hours.	d.	m.
vi.	00	00
1	3	3 45
2	1	7 30
3	1	11 15
viii.	5	1 00
1	3	18 45
2	2	22 30
3	1	26 15
viii.	iv.	30 00
1	3	33 45
2	2	37 30
3	1	41 15
ix.	iii.	45 00
1	3	48 45
2	2	52 30
3	1	56 15
x.	ii.	60 00
1	3	63 45
2	2	67 30
3	1	72 15
xi.	i.	75 00

*A Table shewing
what Angle every
Hour, Quarters,
Halves, and Three
Quarters of an
Hour makes in a
Polar Dial.*

Hours.	d.	m.
xii.	00	00
1	3	3 45
2	2	7 30
3	1	11 15
i.	xi.	15 00
1	3	18 45
2	2	22 30
3	1	26 15
ii.	x.	30 00
1	3	33 45
2	2	37 30
3	1	41 15
iii.	ix.	45 00
1	3	58 45
2	2	52 30
3	1	56 15
iv.	viii.	60 00
1	3	63 45
2	2	67 30
3	1	72 15
v.	vii.	75 00
1	3	78 45
2	2	82 30
3	1	86 15
vi.	90	00

A TABLE of *Hour Distances*, and Parts of an *Hour* from the *Substile*, in *Declining Dials*, in the Latitude 51 deg. 30 min.

South Declining 1. 00.			South Declining 2 00.			South Declining 3. 00.		
Hours.	d.	m.	Hours.	d.	m.	Hours.	d.	m.
vi.	93	28	vi.	94	06	vi.	96	06
I	3	86	I	3	86	I	3	90
2	2	80	2	2	80	2	2	84
3	3	74	3	1	76	3	1	78
vii.	v.	68	vii.	v.	70	vii.	v.	72
I	3	63	I	3	64	I	3	66
2	2	58	2	2	59	2	2	61
3	1	53	3	1	54	3	1	56
viii.	iv.	48	viii.	iv.	50	viii.	iv.	52
I	3	44	I	3	45	I	3	47
2	2	39	2	2	41	2	2	43
3	1	36	3	1	37	3	1	39
ix.	iii.	33	ix.	iii.	34	ix.	iii.	35
I	3	28	I	3	30	I	3	31
2	2	25	2	2	27	2	2	28
3	1	22	3	1	24	3	1	25
x.	ii.	20	x.	ii.	21	x.	ii.	22
I	3	17	I	3	18	I	3	19
2	2	15	2	2	16	2	2	17
3	1	12	3	1	13	3	1	14
xi.	i.	10	xi.	i.	10	xi.	i.	11
I	3	7	I	3	08	I	3	09
2	2	5	2	2	06	2	2	07
3	1	3	3	1	03	3	1	04
xii.	0	48	xii.	01	36	xii.	02	23
Sub-	stile		Sub-	stile		Sub-	stile	
I	3	1	I	3	00	I	3	00
2	3	3	2	2	03	2	2	02
3	1	6	3	1	05	3	1	03

(1)			(2)			(3)		
i.	xi.	08 38	i.	xi.	07 49	i.	xi.	07 00
1	3	11 04	1	3	10 15	1	3	09 25
2	2	13 30	2	2	12 43	2	2	11 52
3	1	16 10	3	1	15 16	3	1	14 24
ii.	x.	18 50	ii.	x.	17 45	ii.	x.	17 00
1	3	21 36	1	3	20 39	1	3	19 41
2	2	24 30	2	2	23 30	2	2	22 30
3	1	28 05	3	1	27 01	3	1	25 27
iii.	ix.	30 45	iii.	ix.	29 39	iii.	ix.	28 32
1	3	34 09	1	3	33 00	1	3	31 48
2	2	37 45	2	2	36 32	2	2	35 16
3	1	41 46	3	1	40 15	3	1	38 56
iv.	viii.	45 41	iv.	viii.	44 17	iv.	viii.	42 52
1	3	50 07	1	3	48 33	1	3	47 02
2	2	54 04	2	2	53 05	2	2	51 30
3	1	59 58	3	1	57 55	3	1	56 14
v.	vii.	64 51	v.	vii.	63 03	v.	vii.	61 16
1	3	70 21	1	3	68 27	1	3	66 38
2	2	76 04	2	2	74 06	2	2	72 09
3	1	81 55	3	1	79 57	3	1	77 56
vi.		86 56	vi.		85 54	vi.		83 53

South Declining. South Declining. South Declining.

04 00.

05 00.

06 00.

Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.			
vi.	99	12	2	2	88	13	2	90	25		
I	3	92	12	3	1	82	11	3	1	84	12
2	2	86	11	vii.	v.	76	17	vii.	v.	78	14
3	1	80	11	1	3	70	32	1	3	72	25
vii.	v.	74	19	2	2	65	01	2	2	66	49
I	3	68	40	3	1	59	47	3	1	61	28
2	2	63	15	viii.	iv.	54	49	viii.	iv.	56	25
3	1	58	06	1	3	50	10	1	3	51	39
viii.	iv.	53	14	2	2	45	44	2	2	47	10
3	1	48	40	3	1	41	40	3	1	42	49
2	2	44	24	ix.	iii.	37	50	ix.	iii.	39	03
3	1	40	23	1	3	34	13	1	3	35	02

(4)				(5)				(6)			
ix.	ii.	36	37	2	230	49	2	231	54		
I		333	40	3	I27	36	3	I28	38		
2		229	44	x.	ii.	24	33	x.	ii.	25	22
3		I26	35	I	321	39	I	322	35		
x.	ii.	23	35	2	218	53	2	219	47		
I		320	45	3	I16	13	3	I17	05		
2		218	00	xi.	i.	13	36	xi.	i.	14	30
3		I15	21	I	311	09	I	311	58		
xi.	i.	12	49	2	208	49	2	209	31		
I		310	20	3	I06	23	3	I07	07		
2		207	55	xii.	03	50	xii.	04	45		
3		I05	52	I	301	38	I	302	25		
	xii.	03	11	Sub-	ftile.	2		Sub-	ftile.	2	00
I		330	51	2	203	53	Sub-	ftile.			
	Sub-	ftile.	3		I03	01	3	I02	14		
2		201	29	i.	xi.	05	23	i.	xi.	04	34
3		I03	49	I	307	45	I	306	56		
i.	xi.	06	11	2	210	10	2	209	20		
I		308	44	3	I12	38	3	I11	46		
2		210	43	ii.	x.	15	10	ii.	x.	14	17
3		I13	30	I	317	48	I	316	52		
ii.	x.	16	04	2	220	32	2	219	34		
I		318	44	3	I23	22	3	I22	22		
2		220	45	iii.	ix.	26	21	iii.	ix.	25	17
3		I23	36	I	329	30	I	328	22		
iii.	ix.	27	26	2	232	49	2	231	37		
I		330	38	3	I36	20	3	I35	04		
2		234	01	iv.	viii.	39	05	iv.	viii.	38	52
3		I37	37	I	344	05	I	342	39		
iv.	viii.	41	26	2	248	21	2	246	49		
I		345	31	3	I52	54	3	I51	16		
2		248	42	v.	vii.	57	44	v.	vii.	56	01
3		I53	16	I	362	52	I	361	03		
v.	vii.	59	28	2	268	16	2	266	23		
I		364	41	3	I73	57	3	I71	58		
2		270	11	vi.	79	46	vi.	77	46		
3		I75	53	I	385	45	I	383	43		
	vi.	81	48								

South Declining.			South Declining.			South Declining.		
07 00			08 00			09 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
2	292	18	2	294	26	2	296	16
3	186	14	3	188	17	3	190	23
vii.	v. 80	13	vii.	v 82	13	vii	v 84	15
1	374	21	1	377	52	1	378	14
2	268	38	2	270	32	2	272	23
3	163	12	3	164	58	3	166	45
viii	iv 58	02	viii	iv 59	32	viii	iv 61	23
1	353	10	1	354	45	1	356	38
2	248	35	2	250	04	2	251	31
3	144	18	3	145	40	3	147	02
ix	iii 39	17	ix	iii 41	34	ix	iii 42	50
1	336	30	1	338	44	1	338	52
2	232	59	2	234	07	2	235	14
3	129	39	3	130	43	3	131	46
x	ii 26	30	x	ii 27	30	x	ii 28	24
1	323	32	1	324	49	1	325	25
2	220	40	2	221	36	2	222	29
3	117	57	3	118	49	3	119	41
xi	i 15	19	xi	i 16	10	xi	i 17	10
1	312	47	1	313	56	1	314	26
2	210	20	2	211	07	2	211	06
3	107	54	3	108	42	3	109	21
xii	05	32	xii	06	19	xii	07	05
1	302	42	1	303	59	1	304	45
2	200	53	2	201	40	2	202	26
Sub-	stile.		Sub-	stile.		3	100	07
3	101	29	3	100	59	Sub-	stile.	
i	xi 03	36	i	xi 02	59	i	xi 02	11
1	306	06	1	305	19	1	304	30
2	208	30	2	207	40	2	206	51
3	110	55	3	110	04	3	109	13
ii	x 13	24	ii	x 12	33	ii	x 11	40
1	315	28	1	315	03	1	315	09
2	218	36	2	217	40	2	216	44
3	121	22	3	120	22	3	119	24

(7)			(8)			(9)		
iii.	ix.	24 19	iii.	ix.	23 13	iii.	ix.	22 08
I		3 27 16	I		3 26 11	I		3 25 09
2		2 30 28	2		2 29 19	2		2 28 10
3		1 33 50	3		1 32 37	3		1 31 25
iv	viii	37 26	iv	viii	36 08	iv	viii	34 15
I		3 42 16	I		3 39 52	I		3 38 30
2		2 45 20	2		2 43 52	2		2 42 22
3		1 49 21	3		1 48 08	3		1 46 34
v	vii	54 20	v	vii	52 40	v	vii	51 04
I		3 59 16	I		3 57 31	I		3 56 49
2		2 64 30	2		2 62 39	2		2 60 50
3		1 70 02	3		1 68 05	3		1 66 10
vi		75 45	vi		73 46	vi		71 46
I		3 40 81	I		3 79 38	I		3 77 36

South Declining. South Declining. South Declining.

10 00			11 00			21 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
3		1 92 22	3		1 94 25	3		1 96 35
vii	v	86 15	vii	v	88 17	vii	v	90 20
I		3 80 12	I		3 82 10	I		3 84 01
2		2 74 16	2		2 76 11	2		2 78 03
3		1 68 32	3		1 70 22	3		1 72 10
viii	iv	63 04	viii	iv	64 48	viii	iv	66 29
I		3 57 53	I		3 59 30	I		3 61 05
2		2 53 00	2		2 54 30	2		2 55 19
3		1 48 25	3		1 49 49	3		1 51 12
ix	iii	44 07	ix	iii	45 25	ix	iii	46 42
I		3 40 06	I		3 41 19	I		3 42 30
2		2 36 21	2		2 37 59	2		2 38 36
3		1 32 49	3		1 33 53	3		1 34 56
x	ii	29 28	x	ii	30 30	x	ii	31 28
I		3 26 22	I		3 27 38	I		3 28 14
2		2 23 24	2		2 24 18	2		2 25 11
3		1 20 34	3		1 21 25	3		1 22 06

(10)				(11)				(12)			
xi	i	17	15	xi	i	18	40	xi	i	19	29
1	3	15	14	1	3	16	03	1	3	16	08
2	2	12	43	2	2	13	30	2	2	14	16
3	1	10	16	3	1	11	03	3	1	11	47
xii	07	52		xii	08	38		xii	09	23	
1	3	05	31	1	3	06	17	1	3	07	00
2	2	03	12	2	2	03	51	2	2	04	40
3	1	00	54	3	1	01	39	3	1	02	23
Sub-		ftile.		Sub-		ftile.	i	xi		00	16
i	xi	01	25	i	xi	00	38	Sub-		ftile.	
1	3	03	43	1	3	02	57	1	3	02	11
2	2	06	02	2	2	05	15	2	2	04	29
3	1	08	24	3	1	07	35	3	1	06	48
ii	x	10	48	ii	x	09	59	ii	x	09	09
1	3	13	13	1	3	12	42	1	3	11	34
2	2	15	49	2	2	14	55	2	2	14	03
3	1	18	27	3	1	17	30	3	1	16	36
iii	ix	21	12	iii	ix	20	17	iii	ix	19	04
1	3	24	03	1	3	23	01	1	3	22	00
2	2	27	03	2	2	25	58	2	2	24	54
3	1	30	14	3	1	29	05	3	1	27	57
iv	viii	33	36	iv	viii	32	23	iv	viii	31	11
1	3	37	10	1	3	35	52	1	3	34	40
2	2	41	00	2	2	39	36	2	2	38	15
3	1	45	04	3	1	43	35	3	1	42	09
v	vii	49	26	v	vii	47	51	v	vii	46	20
1	3	54	04	1	3	52	37	1	3	50	49
2	2	49	02	2	2	57	16	2	2	55	33
3	1	64	17	3	1	62	16	3	1	60	37
vi.		69	49	vi.		67	52	vi.		66	00
1	3	75	36	1	3	73	35	1	3	71	39
2	2	81	33	2	2	79	16	2	2	77	32

South Declining.			South Declining.			South Declining.				
13 00.			14 00.			15 00				
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.		
3	196	43	vii	v	94	25	vii	v	96	28
vii	v	90	43	i	388	13	i	3	91	16
1	386	11	2	182	01	8	2	184	02	
2	280	04	3	175	58	3	1	177	54	
3	174	05	viii	iv	70	06	viii	iv	71	56
viii	iv	68	08	i	364	29	i	3	66	12
1	362	48	2	259	10	2	3	60	46	
2	257	35	3	154	09	3	1	55	38	
3	152	42	ix	iii	49	27	ix	iii	50	50
ix	iii	48	04	i	345	02	i	3	46	21
1	343	48	2	240	58	2	2	42	09	
2	239	48	3	137	08	3	1	38	14	
3	136	02	x	ii	33	33	x	ii	34	35
x	ii	32	32	i	330	11	i	3	31	09
1	329	13	2	227	01	2	2	27	56	
2	226	06	3	124	02	3	1	24	53	
3	123	09	xi	i	21	11	xi	i	22	40
xi	i	20	21	i	318	51	i	3	19	15
1	317	38	2	215	21	2	2	16	37	
2	213	04	3	113	20	3	1	14	16	
3	112	27	xii	10	54	xii	11	38		
xii	10	08	1	308	31	i	3	09	15	
1	307	47	2	206	11	2	2	06	55	
2	205	27	3	103	54	3	1	04	37	
3	103	09	i	xi	01	36	i	xi	02	21
i	xi	00	53	Sub-	stile.	1	3	00	05	
Sub-	stile.	1	3	00	39	Sub-	stile.			
1	301	24	2	202	55	2	2	02	10	
2	203	41	3	105	12	3	1	04	26	
3	106	00	ii	x	07	31	ii	x	06	43
ii	x	08	20	1	309	53	1	3	09	04
1	310	42	2	212	18	2	2	11	27	
2	213	45	3	114	47	3	1	13	45	
3	115	40	iii	ix	17	20	iii.	ix.	16	25

(13)			(14)			(15)		
iii	ix	18 16	I	3	19 18	I	3	19 02
I	3	21 00	2	2	22 01	2	2	21 47
2	2	23 50	3	1	24 56	3	1	24 36
3	1	26 49	iv.	viii.	28 50	iv.	viii.	27 41
iv	viii	30 00	I	3	32 06	I	3	30 53
I	3	33 20	2	2	35 35	2	2	34 18
2	2	36 54	3	1	39 19	3	1	37 56
3	1	40 43	v.	vii.	43 18	v.	vii.	41 41
v	vii	44 43	I	3	47 34	I	3	45 58
I	3	49 09	2	2	52 07	2	2	50 28
2	2	53 49	3	1	57 00	3	1	55 14
3	1	58 47	vi.	62	11	vi.	60	21
vi	64	04	I	3	67 42	I	3	65 46
I	3	69 39	2	2	73 28	2	2	71 28
2	2	77 04	3	1	77 50	3	1	77 24

South Declining. South Declining. South Declining.

16 00.			17 00.			18 00.		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
vii.	v.	98 31	vii	v	100 33	vii	v	102 38
I	3	92 17	I	3	94 20	I	3	96 32
2	2	86 01	2	2	88 02	2	2	90 05
3	1	79 49	3	1	81 37	3	1	82 46
viii.	iv.	73 45	viii	iv	75 38	viii	iv	77 32
I	3	67 55	I	3	69 42	I	3	71 30
2	2	62 21	2	2	64 02	2	2	65 43
3	1	57 07	3	1	58 40	3	1	60 14
ix.	iii.	52 11	ix	iii	53 58	ix	iii	55 04
I	3	47 36	I	3	48 56	I	3	50 16
2	2	43 18	2	2	44 33	2	2	45 46
3	1	39 19	3	1	40 24	3	1	41 36
x.	ii.	35 35	x	ii	36 39	x	ii	37 42
I	3	22 05	I	3	32 29	I	3	34 04
2	2	28 29	2	2	29 45	2	2	30 44
3	1	25 43	3	1	26 37	3	1	27 29

(16)			(17)			(18)		
xi	i	22 48	xi	i	23 36	xi	i	24 28
1		3 20 01	1		3 20 50	1		3 21 38
2		2 17 22	2		2 17 45	2		2 18 54
3		1 14 49	3		1 15 35	3		1 16 18
xii		12 22	xii		13 05	xii		13 49
1		3 09 57	1		3 10 41	1		3 11 24
2		2 07 37	2		2 08 21	2		2 09 02
3		1 05 14	3		1 06 05	3		1 06 44
i	xi	04 04	i	xi	02 37	i	xi	04 29
1		3 00 49	1		3 01 32	1		3 02 16
Sub-		ftile.	Sub-		ftile.	2		2 00 02
2		2 01 26	2		2 00 53	Sub-		ftile.
3		1 03 40	3		1 02 56	3		1 02 12
ii	x	05 57	ii	x	05 11	ii	x	04 25
1		3 08 15	1		3 07 28	1		3 06 12
2		2 10 36	2		2 09 47	2		2 08 59
3		1 13 00	3		1 12 10	3		1 11 20
iii	ix	15 30	iii	ix	14 37	iii	ix	13 45
1		3 18 05	1		3 17 09	1		3 16 14
2		2 20 47	2		2 19 49	2		2 18 50
3		1 23 34	3		1 22 54	3		1 21 33
iv	viii	26 33	iv	viii	25 28	iv	viii	24 24
1		3 29 41	1		3 28 33	1		3 27 34
2		2 33 01	2		2 31 48	2		2 30 35
3		1 36 34	3		1 35 54	3		1 33 58
v	vii	40 22	v	vii	38 59	v	vii	37 36
1		3 44 26	1		3 42 58	1		3 41 29
2		2 48 48	2		2 47 53	2		2 45 40
3		1 53 30	3		1 51 49	3		1 50 01
vi.		58 30	vi.		56 44	vi.		54 58
1		3 63 50	1		3 61 58	1		3 60 06
2		2 69 28	2		2 67 32	2		2 65 34
2		1 75 23	3		1 73 20	3		1 71 21

South Declining.			South Declining.			South Declining.		
19 00			20 00			21 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
1	3	98 28	1	3	100 31	1	3	102 39
2	2	92 07	2	2	96 16	2	2	96 14
3	1	85 44	3	1	83 47	3	1	89 48
viii	iv	79 28	viii	iv	81 25	viii	iv	83 22
1	3	73 19	1	3	75 11	1	3	77 02
2	2	67 26	2	2	69 10	2	2	70 55
3	1	61 50	3	1	63 27	3	1	65 04
ix	iii	56 32	ix	iii	57 21	ix	iii	59 32
1	3	51 37	1	3	53 00	1	3	54 32
2	2	47 00	2	2	48 16	2	2	49 31
3	1	42 44	3	1	43 45	3	1	45 02
x	ii	38 45	x	ii	39 50	x	ii	40 53
1	3	35 02	1	3	36 02	1	3	37 01
2	2	31 35	2	2	32 32	2	2	33 25
3	1	28 20	3	1	29 12	3	1	30 03
xi	i	25 17	xi	i	26 06	xi	i	26 51
1	3	22 23	1	3	23 10	1	3	23 56
2	2	17 39	2	2	20 24	2	2	21 08
3	1	19 02	3	1	17 45	3	1	18 28
xii	14	31	xii	15	13	xii	15	54
1	3	12 00	1	3	12 47	1	3	13 26
2	2	09 44	2	2	13 25	2	2	11 04
3	1	07 26	3	1	08 07	3	1	08 23
i	xi	05 11	i	xi	05 52	i	xi	06 32
1	3	02 59	1	3	03 37	1	3	04 18
2	2	00 44	2	2	01 26	2	2	02 27
Sub-	file.		Sub-	file.		Sub-	file.	
3	1	01 28	3	1	00 46	3	1	00 04
ii	x	03 41	ii	x	02 58	ii	x	02 14
1	3	05 56	1	3	05 10	1	3	04 27
2	2	08 12	2	2	07 25	2	2	06 40
3	1	10 31	3	1	09 43	3	1	08 55
iii	ix	12 53	iii	ix	12 03	iii	ix	11 13
1	3	15 41	1	3	14 28	1	3	13 36

(19)			(20)			(21)		
2	2 17	54	2	2 16	58	2	2 16	05
3	1 20	34	3	1 19	35	3	1 18	37
iv	viii 23	20	vi	viii 22	19	iv	viii 21	18
1	3 26	41	1	3 25	11	1	3 24	07
2	2 29	24	2	2 28	14	2	2 27	05
3	1 32	41	3	1 31	28	3	1 30	15
v	vii 36	15	v	vii 24	56	v	vii 33	38
1	3 40	04	1	3 38	38	1	3 37	14
2	2 44	07	2	2 42	37	2	2 41	08
3	1 48	30	3	1 46	54	3	1 45	18
vi	53	13	vi	51	30	vi	49	49
1	3 58	16	1	3 56	27	1	3 54	40
2	2 63	38	2	2 61	45	2	2 59	52
3	1 69	21	3	1 67	23	3	1 65	25
vii	v 75	21	vii	v 73	19	vii	v 71	17
South Declining.			South Declining.			South Declining.		
22 00			23 20			24 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
1	3 105	15	1	3 106	38	2	3 100	25
2	2 98	16	2	2 100	22	3	1 95	56
3	1 91	49	3	1 93	54	viii	iv 89	21
viii	iv 85	20	viii	iv 87	21	1	3 82	47
1	3 78	56	1	3 80	52	2	2 76	20
2	2 72	42	2	2 74	31	3	1 70	07
3	1 66	45	3	1 68	25	ix	iii 64	12
ix	iii 61	04	ix	iii 62	38	1	3 58	38
1	3 55	46	1	3 54	13	2	2 53	26
2	2 50	49	2	2 52	08	3	1 48	37
3	1 46	14	3	1 47	25	x	ii 44	08
x	ii 41	58	vi	43	03	1	3 39	49
1	3 38	01	1	3 39	00	2	2 36	11
2	2 34	20	2	2 35	16	3	1 32	37
3	1 30	55	3	1 31	46	xi	1 29	19

(22)			(23)			(24)		
xi	i	27 43	xi	i	28 31	1	3	26 12
1	3	24 42	1	3	25 28	2	2	23 17
2	2	21 52	2	2	22 35	3	1	20 32
3	1	19 10	3	1	19 51	xii	1	17 55
xii	16	36	xii	17	16	1	3	15 25
1	3	14 07	1	3	14 47	2	2	13 02
2	2	11 44	2	2	12 23	3	1	10 42
3	1	09 26	3	1	10 04	i	x	08 27
i	xi	07 10	i	xi	07 49	1	3	05 15
1	3	04 57	1	3	05 37	2	2	04 04
2	2	02 46	2	2	03 26	3	1	01 53
3	1	00 36	3	1	01 16	Sub.	ftile.	
Sub.	ftile.		Sub.	ftile.		ii	x	00 13
ii	x	01 34	ii	x	00 52	1	3	02 20
1	3	04 38	1	3	03 01	2	2	04 30
2	2	05 56	2	2	05 09	3	1	06 40
3	1	08 10	3	1	07 26	iii	ix	08 54
iii	ix	10 26	iii	ix	09 39	1	3	11 09
1	3	12 47	1	3	11 57	2	2	13 29
2	2	15 12	2	2	14 23	3	1	15 54
3	1	17 43	3	1	16 47	iv	viii	18 25
iv	viii	20 19	iv	viii	19 21	1	3	21 04
1	3	23 06	1	3	22 03	2	2	23 51
2	2	26 00	2	2	24 52	3	1	26 48
3	1	29 06	3	1	27 95	v	vii	29 54
v	vii	32 24	v	vii	31 08	1	3	33 18
1	3	35 53	1	3	34 34	2	2	36 54
2	2	39 43	2	2	38 17	3	1	40 47
3	1	43 48	3	1	42 15	vi.	4	44 59
vi.	48	12	vi.	46	33	1	3	49 31
1	3	52 57	1	3	51 12	2	2	54 25
2	2	58 63	2	2	56 12	3	1	59 07
3	1	63 31	3	1	61 34	vii	v	65 20
vii	v	69 18	vii	v	67 18	1	3	71 19

South Declining. 25 00.			South Declining. 26 00.			South Declining. 27 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
2	2	103 28	2	2	106 33	1	3	108 35
3	1	98 00	3	1	100 06	2	2	102 10
viii	iv	91 47	viii	iv	94 21	viii	iv	95 31
1	3	84 45	1	3	86 45	1	3	88 46
2	2	78 13	2	2	81 53	2	3	82 02
3	1	71 53	3	1	73 43	3	1	75 28
ix	iii	65 49	ix	iii	67 27	ix	iii	69 09
1	3	60 07	1	3	62 10	1	3	63 10
2	2	54 48	2	2	56 08	2	2	57 33
3	1	49 51	3	1	51 04	3	1	52 20
x	ii	45 16	x	ii	46 22	x	ii	47 31
1	3	41 02	1	3	42 02	1	3	42 50
2	2	37 08	2	2	38 02	2	2	38 58
3	1	33 30	3	1	34 19	3	1	35 12
xi	i	30 07	xi	i	30 53	xi	i	31 41
1	3	26 58	1	3	27 43	1	3	28 27
2	2	24 00	2	2	24 42	2	2	25 24
3	1	21 16	3	1	21 53	3	1	22 28
xii	18	33	xii	19	13	xii	19	51
1	3	16 04	1	3	16 02	1	3	16 39
2	2	13 39	2	2	13 37	2	2	14 14
3	1	11 20	3	1	11 19	3	1	12 31
i	xi	09 04	i	xi	09 40	i	xi	10 16
1	3	06 54	1	3	07 38	1	3	08 03
2	2	04 42	2	2	05 19	2	2	06 55
3	1	02 34	3	1	03 11	3	1	02 47
ii	x	00 02	ii	x	01 05	ii	x	01 40
Sub-	stile.		Sub-	stile.		Sub-	stile.	
1	3	01 40	1	3	01 01	1	3	01 23
2	2	03 47	2	2	02 33	2	2	02 28
3	1	05 58	3	1	05 15	3	1	05 34
iii	ix	08 08	iii	ix	07 24	iii	ix	07 42
1	3	10 22	1	3	09 35	1	3	09 51
2	2	12 41	2	2	11 51	2	2	11 09
3	1	15 03	3	1	14 11	3	1	13 22

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(23)				(26)				(27)			
iv	viii	17	31	iv	viii	16	36	iv	viii	35	46
I		320	32	I		319	08	I		318	13
2		222	44	2		221	47	2		220	50
3		125	47	3		124	36	3		123	34
v	vii	28	47	v	vii	27	36	v	vii	26	29
I		332	03	I		330	47	I		329	36
2		235	34	2		234	13	2		232	57
3		139	29	3		137	54	3		136	32
	vi.	43	28		vi.	41	54		vi	40	26
I		347	54	I		347	26	I		345	50
2		252	41	2		252	13	2		250	31
3		157	51	3		157	24	3		154	11
vii	v	63	24	vii	v	61	26	vii	v	59	33
I		360	18	I		367	16	I		365	19

South Declining

28 00

South Declining

29 00

South Declining

30 00

Hours.	d.	m.	Hours.	d.	m.	Hours.	d.	m.			
3	1	104	15	3	1	106	21	3	1	108	25
viii.	iv.	97	36	viii.	iv.	99	42	viii.	iv.	101	47
I		391	20	I		392	17	I		394	55
2		284	01	2		286	00	2		288	00
3		177	19	3		179	12	3		181	05
ix.	iii.	70	52	ix.	iii.	72	36	ix.	iii.	74	21
I		364	43	I		366	18	I		367	55
2		258	58	2		260	24	2		261	52
3		153	37	3		154	54	3		156	16
x.	ii.	48	40	x.	ii.	49	50	x.	ii.	51	00
I		344	07	I		345	09	I		346	12
2		239	57	2		240	52	2		241	48
3		136	04	3		136	55	3		137	46
xi.	i.	32	26	xi.	i.	33	16	xi.	i.	34	02
I		329	10	I		329	50	I		330	37
2		226	06	2		236	38	2		227	26
3		123	12	3		123	50	3		124	27

(28)			(29)			(30)		
xii	20	29	xii	21	05	xii	21	40
1	3 17	55 I	1	3 18	30 I	1	3 19	04
2	2 15	27 2	2	2 15	59 2	2	2 15	35
3	1 13	06 3	3	1 13	40 3	3	1 14	13
xi	10	51 I	xi	11	24 I	xi	11	57
1	3 08	38 I	1	3 09	12 I	1	3 09	44
2	2 06	30 2	2	2 07	03 2	2	2 07	36
3	1 04	04 3	3	1 04	58 3	3	1 05	32
ii	x 02	19 II	ii	x 02	54 II	ii	x 02	28
I	3 00	15 I	I	3 00	54 I	I	3 01	26
Sub-	stile.		Sub-	stile.		Sub-	stile.	
2	2 01	49 2	2	2 01	11	2	3 00	35
3	1 03	54 3	3	1 03	14 3	3	1 02	37
iii	ix 06	00 III	iii	ix 05	18 III	iii	ix 04	39
I	3 08	08 I	I	3 07	25 I	I	3 06	43
2	2 10	18 2	2	2 09	34 2	2	2 08	50
3	1 12	33 3	3	1 11	46 3	3	1 11	00
iv	viii 14	53 IV	iv	viii 14	03 IV	iv	viii 13	84
1	3 17	18 I	1	3 16	25 I	1	3 15	34
2	2 19	51 2	2	2 18	54 2	2	2 18	00
3	1 22	33 3	3	1 21	32 3	3	1 20	34
v	vii 25	23 V	v	vii 24	18 V	v	vii 23	16
I	3 28	25 I	I	3 27	16 I	I	3 26	09
2	2 31	41 2	2	2 30	29 2	2	2 29	15
3	1 35	11 3	3	1 33	51 3	3	1 32	34
vi.	38	58	vi.	37	32	vi.	36	09
I	3 43	05 I	I	3 41	34 I	I	3 40	03
2	2 47	31 2	2	2 45	54 2	2	2 44	18
3	1 51	24 3	3	1 50	38 3	3	1 48	56
vii	v 47	39 VII	vii	v 55	47 VII	vii	v 53	58
I	3 63	19 I	I	3 61	20 I	I	3 54	25
2	2 69	22 2	2	2 67	19 2	2	2 65	19

South Declining 31 00			South Declining 32 00			South Declining 33 00		
Hours.	d.	m.	Hours.	d.	m.	Hours.	d.	m.
3	I	110 29	3	I	112 32	viii. iv.	108 07	
viii. iv.	103 54		viii. iv.	106 00		I	3 101 16	
I	3 97 21		I	3 99 05		2	2 94 11	
2	2 90 02		2	2 92 05		3	1 87 00	
3	1 83 02		3	1 85 00		ix. iii.	79 53	
ix. iii.	76 10		ix. iii.	78 00		I	3 23 00	
I	3 69 35		I	3 71 16		2	2 66 27	
2	2 63 22		2	2 64 53		3	1 60 19	
3	1 57 34		3	1 58 55		x. ii.	54 39	
x. ii.	52 12		x. ii.	53 25		I	3 49 27	
I	3 47 17		I	3 48 21		2	2 44 42	
2	2 42 46		2	2 43 43		3	1 41 00	
3	1 38 38		3	1 39 29		xi.	i. 36 23	
xi. i.	34 50		xi. i.	35 36		I	3 32 45	
I	3 30 20		I	3 32 02		2	2 29 24	
2	2 28 06		2	2 28 45		3	1 26 18	
3	1 25 05		3	1 25 42		xii.	23 25	
xii.	22 17		xii.	27 51		I	3 20 43	
I	3 19 38		I	3 20 11		2	2 18 16	
2	3 17 08		2	2 12 40		3	1 15 47	
3	1 14 45		3	1 15 16		i. xi.	13 30	
i. xi.	12 28		i. xi.	12 59		I	3 11 18	
I	3 10 17		I	3 10 48		2	2 09 09	
2	2 08 09		2	2 08 39		3	1 07 06	
3	1 06 04		3	1 06 35		ii. x.	05 05	
ii. x.	04 02		ii. x.	04 34		I	3 03 11	
I	3 02 01		I	3 02 34		2	2 02 08	
2	2 00 01		2	2 00 35		Sub-	stile	
Sub-	stile		Sub-	stile		3	1 00 49	
3	1 02 00		3	1 01 24		iii. ix.	02 47	
iii. ix.	04 01		iii. ix.	03 24		I	3 04 46	
I	3 06 03		I	3 05 24		2	2 06 46	
2	2 08 08		2	2 07 27		3	1 08 50	
3	1 10 15		3	1 09 32		iv. viii.	10 57	

(31)				(32)				(33)			
iv	viii	12	28	iv.	viii.	11	41	iv.	viii.	13	08
1	3	14	44	1	3	13	55	1	3	15	18
2	2	17	07	2	2	16	15	2	2	17	47
3	1	19	37	3	1	18	41	3	1	20	17
v	vii	22	15	v.	vii.	21	15	v.	vii.	22	58
1	3	25	04	1	3	22	00	1	3	25	49
2	2	28	04	2	2	26	56	2	2	28	52
3	1	31	18	3	1	30	04	3	1	32	11
vi		34	48	vi.		33	29	vi.		35	46
1	3	38	36	1	3	38	19	1	3	39	40
2	2	42	43	2	2	41	12	2	2	43	57
3	1	47	15	3	1	45	35	3	1	48	38
vii	v	52	09	vii	v	50	24	vii	v	55	09
1	3	57	31	1	3	45	38	1	3	59	21
2	2	63	19	2	2	61	20	2	2	65	25

South Declining. South Declining. South Declining.

34 00.				35 00				36 00.			
Hours.	D.	M.		Hours.	D.	M.		Hours.	D.	M.	
viii. iv.	110	14		viii. iv	112	18		viii. iv	114	22	
1	3	103	25	1	3	105	27	1	3	107	40
2	2	96	19	2	2	98	25	2	2	100	34
3	1	89	04	3	1	91	17	3	1	93	12
ix. iii.	81	50		ix. iii	83	47		ix. iii	85	46	
1	3	74	48	1	3	76	37	1	3	78	26
2	2	68	04	2	2	69	42	2	2	71	21
3	1	61	46	3	1	63	14	3	1	64	41
x. ii.	55	56		x. ii	57	13		x. ii	58	32	
1	3	50	35	1	3	51	42	1	3	52	51
2	2	45	42	2	2	46	41	2	2	47	39
3	1	41	14	3	1	42	07	3	1	43	00
vii. v.	37	10		vii. v	37	57		vii. v	38	43	
1	3	33	28	1	3	34	09	1	3	34	50
2	2	30	03	2	2	30	41	2	2	31	18
3	1	26	54	3	1	27	29	3	1	28	03
xii. 23		56		xii. 24		31		xii. 25		04	

(34)			(35)			(36)		
08	1	3 21 16	1	3 21 46	1	3 22 16		
18	2	2 18 42	2	2 19 12	2	2 17 40		
47	3	1 16 17	3	1 16 46	3	1 17 13		
17	i.	xi 14 00	i.	xi 14 24	i.	xi 14 54		
58	1	3 11 47	1	3 12 15	1	3 12 42		
49	2	2 09 40	2	2 10 08	2	2 10 35		
52	3	1 07 36	3	1 08 05	3	1 06 32		
11	ii	x 05 36	ii	x 06 06	ii	x 08 32		
46	i	3 03 38	i	3 04 08	i	3 06 33		
40	2	2 01 41	2	2 02 19	2	2 04 37		
57	Sub-	ftile. 3	1 00 18	3	1 00 49			
38	3	1 00 15	Sub-	ftile. 3	1 00 49			
09	iii	ix 02 11	iii	ix 01 37	iii	ix 01 05		
21	1	3 04 09	1	3 03 34	1	3 02 58		
25	2	2 06 07	2	2 05 30	2	2 04 53		
ng.	3	1 08 08	3	1 07 29	3	1 06 50		
	iv	viii 10 12	iv	viii 09 31	iv	viii 08 49		
M	1	3 12 21	1	3 11 36	1	3 10 52		
22	2	2 14 34	2	2 13 47	2	2 13 00		
40	3	1 16 54	3	1 15 04	3	1 15 13		
34	vii	19 21	v	vii 18 27	v	vii 17 33		
12	1	3 21 57	1	3 20 58	1	3 20 00		
46	2	2 24 43	2	2 23 40	2	2 22 38		
26	3	1 27 10	3	1 26 34	3	1 25 27		
21	vi.	30 54	vi.	29 41	vi.	28 29		
41	1	3 33 56	1	3 33 04	1	3 31 46		
32	2	2 38 11	2	2 36 46	2	2 35 21		
51	3	1 42 20	3	1 40 49	3	1 39 17		
39	vii	v 46 55	vii	v 45 15	vii	v 43 36		
00	1	3 51 55	1	3 50 18	1	3 48 22		
43	2	2 57 24	2	2 55 30	2	2 53 36		
50	3	1 64 19	3	1 61 21	3	1 59 21		

South Declining. 37 00.			South Declining 38 00.			South Declining. 39 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
1	3	109 41	1	3	112 01	1	3	114 29
2	2	102 45	2	2	104 57	2	2	107 08
3	1	95 21	3	1	97 33	3	1	99 43
ix	iii	87 49	ix	iii	89 56	ix	ii	91 52
1	3	80 21	1	3	82 20	1	3	84 18
2	2	73 06	2	2	74 55	2	2	76 43
3	1	66 15	3	1	67 52	3	1	69 28
x	ii	59 53	x	ii	61 17	x	ii	62 42
1	3	54 02	1	3	55 15	1	3	56 29
2	2	48 42	2	2	49 46	2	2	50 44
3	1	43 52	3	1	44 49	3	1	45 28
xi	i	39 30	xi	i	40 18	xi	i	41 06
1	3	35 32	1	3	36 15	1	3	36 56
2	2	31 55	2	2	32 33	2	2	33 06
3	1	28 37	3	1	29 11	3	1	29 44
xii	25	35	xii	26	04	xii	26	35
1	3	22 29	1	3	23 15	1	3	23 43
2	2	20 06	2	2	20 36	2	2	21 03
3	1	17 40	3	1	18 07	3	1	18 31
i	xi	15 21	i	xi	15 47	i	x	16 12
1	3	13 09	1	3	13 34	1	3	13 59
2	2	11 02	2	2	11 28	2	2	11 52
3	1	09 00	3	1	09 26	3	1	09 51
ii	x	07 01	ii	x	07 08	ii	x	07 53
1	3	05 05	1	3	05 34	1	3	05 58
2	2	03 12	2	2	03 41	2	2	04 00
3	1	01 20	3	1	01 50	3	1	02 18
Sub-	file.		Sub-	file.		Sub-	file.	
iii	ix	00 32	iii	ix	00 01	iii	ix	00 28
1	3	02 24	1	3	01 52	1	3	01 20
2	2	04 17	2	2	03 53	2	2	03 10
3	1	06 13	3	1	05 35	3	1	05 00
iv	vii	08 10	iv	viii	07 30	iv	viii	06 53
1	3	10 10	1	3	09 28	1	3	08 49

(37)				(38)				(39)			
2	2	11	14	2	2	11	00	2	2	10	48
3	1	14	24	3	1	13	37	3	1	12	52
v	vii	16	41	v.	vii.	15	51	v.	vii.	15	01
1	3	19	40	1	3	18	09	1	3	17	18
2	2	21	38	2	2	20	39	2	2	19	49
3	1	24	21	3	1	23	18	3	1	22	17
vi	27	18		vi.	26	09		vi.	25	03	
1	3	30	29	1	3	29	15	1	3	28	03
2	2	33	51	2	2	32	37	2	2	31	20
3	1	37	47	3	1	36	19	3	1	34	54
vii	v	42	00	vii	v	40	23	vii	v	38	51
1	3	46	36	1	3	44	53	1	3	43	14
2	2	51	43	2	2	49	52	2	2	48	05
3	1	57	21	3	1	55	21	3	1	53	27
viii	iv	63	30	viii.	iv.	61	24	viii.	iv.	59	22

South Declining. South Declining. South Declining.

40 00.

41 00

42 00.

Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.			
1	3	116	16	2	2	111	31	2	2	113	45
2	2	111	57	3	1	104	09	3	1	166	17
3	1	101	56	ix	iii	96	22	ix	iii	98	03
ix.	iii.	94	16	1	3	88	15	1	3	90	31
1	3	86	20	2	2	79	18	2	2	82	28
2	2	78	35	3	1	72	38	3	1	74	37
3	1	71	10	x	ii	65	24	x	ii	67	12
x.	ii.	64	10	1	3	58	46	1	3	60	21
1	3	57	44	2	2	52	44	2	2	54	07
2	2	51	54	3	1	47	19	3	1	48	30
3	1	46	42	xi	1	42	27	xi	1	43	29
xi.	i.	41	53	1	3	38	06	1	3	27	52
1	3	37	37	2	2	34	10	2	2	34	58
2	2	53	45	3	1	30	36	3	1	31	19
3	1	30	16	xii	2	27	33	xii	2	28	01
xii	27	03	1	3	24	30	1	3	25	00	

(40)			(41)			(42)		
1	3 24	10 2	2 21	46 2	2 22	15		
2	2 21	27 1	3 19	12 3	1 19	43		
3	1 18	57 1	xi 16	53 1	xi 17	22		
i	xi 16	36 1	3 14	37 1	3 15	03		
1	3 14	22 2	2 12	35 2	2 12	59		
2	2 12	16 3	1 10	34 3	1 10	59		
3	1 10	14 ii.	x. 08	38 ii.	x. 09	02		
ii.	x. 08	17 1	3 06	46 1	3 07	11		
1	3 06	28 2	2 04	53 2	2 05	23		
2	2 04	34 3	1 03	11 3	1 03	36		
3	1 02	45 iii.	ix. 01	25 iii.	ix. 01	51		
iii.	ix. 00	58	Sub.	stile.	1	3 00	03	
	Sub.	stile.	1	3 00	21	Sub.	stile.	
1	3 00	49 2	2 02	07 2	2 02	34		
2	2 02	38 3	1 03	54 3	1 03	22		
3	1 04	27 iv.	viii. 05	42	v. viii. 05	08		
iv.	viii. 06	17 1	3 07	32 1	3 06	57		
1	3 08	10 2	2 09	26 2	2 08	43		
2	2 10	07 3	1 11	24 3	1 10	42		
3	1 12	08 v.	vii. 13	27	v. vii. 12	43		
v.	vii. 14	14 1	3 15	37 1	3 14	49		
1	3 16	27 2	2 17	53 2	2 17	01		
2	2 18	46 3	1 20	19 3	1 19	23		
3	1 21	17 vi.	22	57	vi. 21	54		
	vi. 23	59 1	3 25	42 1	3 24	38		
1	3 26	21 2	2 28	48 2	2 27	37		
2	2 30	03 3	1 32	10 3	1 30	32		
3	1 33	31 vii.	v 35	52	vii v 34	26		
vii	v 37	21 1	3 39	58 1	3 38	25		
1	3 41	35 2	2 44	33 2	2 42	51		
2	2 46	18 3	1 49	38 3	1 47	49		
3	1 51	33 viii	iv 55	19	viii iv 53	20		
viii	iv 57	20 1	3 61	35 1	3 59	29		

South Declining.			South Declining.			South Declining.		
43 °°			44 °°			45 °°		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
iii ix	100	54	ix iii	103	10	ix iii	105	29
1	3 92	45	1	3 94	56	1	3 97	23
2	2 84	31	2	2 86	29	2	2 88	39
3	1 76	28	3	1 78	10	3	1 80	25
ii x	68	48	x ii	70	15	x ii	72	27
1	3 61	36	1	3 62	58	1	3 64	27
2	2 55	10	2	2 56	15	2	2 57	29
3	1 49	30	3	1 50	15	3	1 51	30
xi	1 44	19	xi	1 44	58	xi	1 45	58
1	3 40	00	1	3 40	12	1	3 40	57
2	2 35	34	2	2 35	58	2	2 36	36
3	1 31	46	3	1 32	13	3	1 32	44
xii	28	29	xii	28	55	xii	29	21
1	3 25	27	1	3 25	40	1	3 26	02
2	2 22	40	2	2 22	52	2	2 23	29
3	1 20	00	3	1 20	17	3	1 20	44
i xi	17	34	i xi	17	51	i xi	18	19
1	3 15	21	1	3 15	25	1	3 15	59
2	2 13	14	2	2 13	34	2	2 13	58
3	1 11	29	3	1 11	35	3	1 12	00
ii x	09	25	ii x	09	41	ii x	10	03
1	3 07	35	1	3 07	56	1	3 08	18
2	2 05	54	2	2 06	18	2	2 06	30
3	1 04	36	3	1 04	30	3	1 04	47
iii ix	02	17	iii ix	02	40	iii ix	02	26
1	3 00	34	1	3 01	08	1	3 01	25
Sub.	file.		Sub.	file.		Sub.	file.	
2	2 01	07	2	2 00	46	2	2 00	15
3	1 02	51	1	3 02	34	1	3 01	53
iv viii	04	38	iv viii	04	20	iv viii	03	34
1	3 06	24	1	3 06	00	1	3 05	15
2	2 08	15	2	2 07	40	2	2 06	59
3	1 10	04	3	1 09	28	3	1 08	30
v vii	11	59	v vii	11	20	v vii	10	37
1	3 14	02	1	3 13	19	1	3 12	21

(43)				(44)				(45)			
2	2	16	11	2	2	15	19	2	2	14	03
3	1	18	28	3	I	17	37	3	1	19	10
	vi	20	55		vi	19	56		vi	19	01
1	3	23	32	1	3	22	30	1	3	21	28
2	2	26	34	2	2	25	18	2	2	24	09
3	1	29	32	3	1	28	20	3	1	27	05
vii	v	33	02	vii	v	31	38	vii	v	30	20
1	3	36	52	1	3	35	26	1	3	33	54
2	2	41	10	2	2	39	33	2	2	37	56
3	1	45	58	3	1	44	14	3	1	42	26
viii	iv	51	22	viii	iv	49	29	viii	iv	47	31

South Declining. *South Declining.* *South Declining.*

46 00

47 00

48 00

<i>Hours.</i>	<i>D.</i>	<i>M.</i>	<i>Hours.</i>	<i>D.</i>	<i>M.</i>	<i>Hours.</i>	<i>D.</i>	<i>M.</i>			
3	i	116	39	I	3	116	57	I	3	117	06
ix	iii	108	50	ix	iii	109	00	ix	ii	117	36
I	3	99	34	I	3	101	51	I	3	104	21
2	2	90	58	2	2	93	21	2	2	95	35
3	i	86	20	3	i	84	25	3	i	86	35
x	ii	73	58	x	ii	75	56	x	i	77	45
I	3	66	10	I	3	67	31	I	3	69	22
2	2	58	58	2	2	60	17	2	2	61	39
3	i	53	09	3	i	53	58	3	i	54	44
xi	i	46	49	xi	i	47	39	xi	i	48	36
I	3	41	41	I	3	43	22	I	3	43	19
2	2	37	18	2	2	37	51	2	2	38	28
3	i	33	19	3	i	33	50	3	i	34	18
xii		29	46	xii		30	11	xii		30	35
I	3	26	35	I	3	25	56	I	3	27	17
2	2	23	41	2	2	24	00	2	2	24	19
3	i	21	03	3	i	21	20	3	i	21	38
i	xi	18	37	i	xi	18	52	i	xi	19	09
I	3	16	21	I	3	16	23	I	3	16	53
2	2	14	15	2	2	14	32	2	2	14	47

(46)			(47)			(48)		
3	1 12	15	3	1 12	29	3	1 12	47
ii.	x. 10	21	ii.	x. 10	37	ii.	x. 10	55
1	3 08	32	1	3 08	50	1	3 09	07
2	2 06	48	2	2 07	07	2	2 07	24
3	1 05	06	3	1 05	20	3	1 05	42
iii.	ix. 03	26	iii.	ix. 03	47	iii.	ix. 04	08
1	3 01	46	1	3 02	12	1	3 02	33
2	2 00	10	2	2 00	35	2	2 00	58
Sub- stile.			Sub- stile.			Sub- stile.		
3	1 01	27	3	1 01	01	3	1 00	23
iv. viii.	03	05	iv. viii.	02	30	iv. viii.	02	09
1	3 04	48	1	3 04	11	1	3 03	45
2	2 06	25	2	2 05	52	2	2 05	21
3	1 08	10	3	1 07	31	3	1 06	59
v. vii.	09	57	v. vii.	09	18	v. vii.	08	42
1	3 11	49	1	3 11	06	1	3 10	28
2	2 13	46	2	2 13	01	2	2 12	19
3	1 15	52	3	1 15	00	3	1 14	16
vi.	18	06	vi.	17	11	vi.	16	21
1	3 20	29	1	3 19	27	1	3 18	35
2	2 23	05	2	2 23	00	2	2 21	00
3	1 25	55	3	1 24	44	3	1 23	38
vii	v 29	20	vii	v 27	42	vii	v 26	32
1	3 32	30	1	3 31	34	1	3 29	45
2	2 36	32	2	2 35	00	2	2 33	21
3	1 40	43	3	1 39	00	3	1 37	24
viii	iv 45	38	viii	iv 43	54	viii	iv 41	54

South Declining. South Declining. South Declining.

40 00.			50 00.			51 00.		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
ix	iii	115 10	ix	iii	117 22	ix.	iii	118 00
1	3	107 46	1	3	109 14	1	3	111 43
2	2	97 50	2	2	91 08	2	2	100 52
3	1	88 53	3	1	81 48	3	1	93 27

(49)			(50)			(51)		
x	ii	79 43	x	ii	81 48	x	ii	83 15
1		3 71 04	1		3 72 49	1		3 74 57
2		2 63 02	2		2 64 30	2		2 65 59
3		1 55 47	3		1 57 02	3		1 58 14
xi		1 49 30	xi		1 50 25	xi		1 51 20
1		3 43 52	1		3 44 40	1		3 45 22
2		2 39 03	2		2 39 35	2		2 40 07
3		1 34 46	3		1 35 13	3		1 35 40
xii		30 58	xii		31 21	xii		31 45
1		3 27 36	1		3 27 55	1		3 28 13
2		2 24 36	2		2 24 52	2		2 25 03
3		1 21 54	3		1 22 07	3		1 22 18
i	xi	19 23	i	xi	19 36	i	xi	19 49
1		3 17 02	1		3 17 20	1		3 17 32
2		2 14 59	2		2 15 11	2		2 15 25
3		1 13 01	3		1 13 14	3		1 13 25
ii	x	11 13	ii	x	11 27	ii	x	11 36
1		3 09 20	1		3 09 46	1		3 09 57
2		2 07 40	2		2 07 57	2		2 08 12
3		1 06 21	3		1 06 27	3		1 06 41
ix	iii	04 30	ix	iii	04 54	ix	iii	04 59
1		3 02 53	1		3 03 12	1		3 03 30
2		2 01 19	2		2 01 41	2		2 01 59
Sub-	stile.	3	Sub-	stile.	3	Sub-	stile.	3
3		1 00 15	3		1 00 10	3		1 00 35
iv	viii	01 47	iv	viii	01 19	iv	viii	00 58
1		3 03 18	1		3 02 50	1		3 02 25
2		2 05 00	2		2 04 22	2		2 03 45
3		1 06 27	3		1 05 56	3		1 05 27
v	vii	08 00	v	vii	07 32	v	vii	07 00
1		3 09 49	1		3 09 12	1		3 08 36
2		2 11 37	2		2 10 57	2		2 10 18
3		1 13 32	3		1 12 47	3		1 12 05
vi.		15 32	vi.		15 03	vi.		14 04
1		3 17 42	1		3 16 49	1		3 15 59
2		2 20 01	2		2 19 03	2		2 18 08
3		1 23 01	3		1 21 30	3		1 20 29
vii	v	25 37	vii	v	24 11	vii	v	23 02

(49)			(50)			(51)		
1	3 28	27 1	3 27	10 1	3 25	59		
2	2 31	55 2	2 30	29 2	2 27	07		
3	1 35	49 3	1 34	14 3	1 32	43		
viii	iv 40	11 viii	iv 37	56 viii	iv 36	56		
South Declining.			South Declining			South Declining.		
52 00			53 00			54 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
1	3 117	21 1	3 118	10 1	3 119	08		
2	2 106	27 2	2 108	05 2	2 110	46		
3	1 96	57 3	1 98	30 3	1 101	06		
x	ii 86	09 x	ii 88	35 x	ii 90	46		
1	3 76	27 1	3 78	29 1	3 80	40		
2	2 67	29 2	2 69	30 2	2 71	00		
3	1 59	22 3	1 60	40 3	1 62	05		
xi	i 52	10 xi	i 55	20 xi	i 56	26		
1	3 45	57 1	3 46	41 1	3 48	15		
2	2 40	40 2	2 41	10 2	2 42	30		
3	1 35	58 3	1 36	30 3	1 37	45		
xii	32	05 xii	32	26 xii	32	46		
1	3 28	24 1	3 28	39 1	3 28	56		
2	2 25	13 2	2 25	25 2	2 25	40		
3	1 22	24 3	1 22	30 3	1 22	50		
xi	19	53 xi	20	12 xi	20	22		
1	3 17	38 1	3 17	45 1	3 17	56		
2	2 15	30 2	2 15	41 2	2 15	49		
3	1 13	35 3	1 13	43 3	1 13	59		
ii.	x. 11	48 ii.	x 11	57 ii.	x. 12	06		
1	3 10	00 1	3 10	08 1	3 10	21		
2	2 08	21 2	2 08	38 2	2 08	43		
3	1 06	44 3	1 07	00 3	1 07	10		
iii	ix 05	18 iii	ix 05	31 iii	ix 05	44		
1	3 03	47 1	3 04	18 1	3 02	15		
2	2 02	18 2	2 02	35 2	2 02	52		
3	1 00	52 3	1 01	11 3	1 01	30		
Sub.	file.	Sub.	file.	viii	iv	00	07	

(52)				(53)				(54)			
iv	viii	00	34	iv	viii	00	12	Sub-	stile.		
1	3	02	00	1	3	01	36	1	3	01	14
2	2	03	28	2	2	03	02	2	2	02	37
3	1	04	46	3	1	04	32	3	1	04	00
v	vii	06	28	v	vii	05	56	v	vii	05	28
1	3	08	03	1	3	07	27	1	3	06	55
2	2	09	40	2	2	09	03	2	2	08	27
3	1	11	23	3	1	10	46	3	1	10	03
vi.	13	13		vi.	12	26		vi	11	46	
1	3	15	10	1	3	14	17	1	3	13	35
2	2	17	18	2	2	16	18	2	2	15	30
3	1	19	30	3	1	18	13	3	1	17	36
vii	v	22	00	vii	v	20	53	vii	v	19	50
1	3	24	44	1	3	23	30	1	3	22	23
2	3	27	53	2	2	26	26	2	3	25	13
3	1	31	01	3	1	29	42	3	2	18	20
viii	iv	35	34	viii	iv	33	33	viii	iv	32	00
South Declining * 55 00				South Declining 56 00				South Declining 57 00			
Hours.	l.	m.		Hours.	d.	m.		Hours.	d.	m.	
1	3	120	02	1	3	122	20	1	3	124	10
2	2	113	20	2	2	116	02	2	2	118	58
3	1	103	34	3	1	106	32	3	1	109	24
x.	ii.	93	24	x.	ii.	96	13	x	ii.	98	55
1	3	82	55	1	3	85	20	1	3	87	56
2	2	72	47	2	2	74	52	2	2	76	58
3	1	63	30	3	1	65	13	3	1	66	47
xi.	i.	55	25	xi.	i.	56	40	xi.	i.	57	50
1	3	48	21	1	3	49	20	1	3	50	10
2	2	42	22	2	2	43	02	2	2	43	40
3	1	37	18	3	1	37	50	3	1	38	12
xii	33	06		xii	33	24		xii	33	42	
1	3	29	10	1	3	29	21	1	3	29	28
2	2	25	52	2	2	26	01	2	2	26	15

(55)				(56)				(57)			
3	I	22	57	3	I	23	05	3	I	23	10
i	xi	20	23	i	xi	20	30	i	xi	20	33
I	3	18	04	I	3	18	10	I	3	18	16
2	2	15	56	2	2	16	03	2	2	16	09
3	I	14	00	3	I	14	10	3	I	14	15
ii	x	12	13	ii	x	12	17	ii	x	12	21
I	3	20	30	I	3	10	40	I	3	10	42
2	2	08	53	2	2	09	07	2	2	09	10
3	I	07	22	3	I	07	31	3	I	07	35
iii	ix	05	53	iii	ix	06	00	iii	ix	06	08
I	3	04	30	I	3	04	43	I	3	04	45
2	2	03	07	2	2	03	22	2	2	03	33
3	I	01	45	3	I	02	02	3	I	02	18
iv	viii	00	26	iv	viii	00	41	iv	viii	01	02
Sub- stile.				Sub- stile.				Sub- stile.			
I	3	00	54	I	3	00	34	I	3	00	14
2	2	02	14	2	2	01	53	2	2	01	30
3	I	03	35	3	I	03	12	3	I	02	47
v	vii	04	02	v	vii	04	33	v	vii	04	06
I	3	06	26	I	3	05	55	I	3	05	26
2	2	07	57	2	2	07	22	2	2	06	49
3	I	09	26	3	I	08	50	3	I	08	15
vi.	I	11	05	vi.	I	10	24	vi.	I	09	44
I	3	12	51	I	3	12	09	I	3	11	22
2	2	14	38	2	2	13	50	2	2	13	08
3	I	16	38	3	I	15	45	3	I	14	57
vii	v	18	50	vii	v	17	52	vii	v	16	35
I	3	21	16	I	3	20	10	I	3	19	10
2	2	24	01	2	2	21	43	2	2	21	38
3	I	27	02	3	I	25	37	3	I	24	22
viii	iv	30	30	viii	iv	28	54	viii	iv	27	30

South Declining. 58 00.			South Declining. 59 00			South Declining. 60 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
2	2	122 10	3	1	114 02	3	1	119 00
3	1	113 18	x	ii	104 40	x	ii	108 40
x	ii	102 38	1	3	94 07	1	3	96 17
1	3	91 23	2	2	81 26	2	2	84 15
2	2	79 08	3	1	70 20	3	1	82 40
3	1	69 20	xi	i	60 28	xi	i	61 35
xi	i	60 10	1	3	51 57	1	3	52 10
1	3	51 20	2	2	44 56	2	2	45 53
2	2	44 20	3	1	38 58	3	1	39 27
3	1	38 39	xii		34 17	xii		34 33
xii		34 00	1	3	55 54	1	3	30 08
1	3	29 50	2	2	26 30	2	2	26 27
2	2	26 20	3	1	23 20	3	1	23 23
3	1	23 20	1	xi	20 38	1	xi	20 41
i	xi	20 39	1	3	18 17	1	3	18 20
1	3	18 23	2	2	16 10	2	2	16 11
2	2	16 13	3	1	14 13	3	1	14 16
3	1	14 18	ii	x	12 30	ii	x	12 31
ii	x	12 30	1	3	10 53	1	3	10 53
1	3	10 56	2	2	09 20	2	2	09 24
2	2	09 18	3	1	07 55	3	1	07 58
1	3	07 39	iii	ix	06 35	iii	ix	06 39
ix	iii	06 26	1	3	05 15	1	3	05 23
1	3	05 64	2	2	03 58	2	2	04 07
2	2	07 46	3	1	02 45	3	1	02 55
3	1	02 31	iv	viii	01 31	iv	viii	01 43
iv	viii	01 16	1	3	00 19	1	3	00 33
1	3	00 02	Sub.		file.	Sub.		file.
Sub.		file.	2	2	00 52	2	2	00 34
2	2	01 10	3	1	02 05	3	1	01 25
3	1	02 25	v	vii	03 18	v.	vii.	32 56
v	vii	03 41	1	3	04 33	1	3	04 03
1	3	04 58	2	2	05 40	2	2	05 23
2	2	06 20	3	1	07 10	3	1	06 40
3	1	07 43	vi.		08 35	vi.		08 20
vi.		09 10	1	3	10 03	1	3	09 26
1	3	10 43	2	2	11 37	2	2	10 57
2	2	12 22	3	1	13 18	3	1	12 36
3	1	14 08	vii	v	15 09	vii	v	14 20
vii	v	16 03	1	3	17 10	1	3	16 15
1	3	18 08	2	2	19 23	2	2	18 22
2	2	20 30	3	1	21 56	3	1	20 45
3	1	23 10	viii	iv	24 46	viii	iv	23 28
viii	iv	26 11						

The SECOND PART.

Arithmetical
And
Instrumental

} D I A L L I N G.



YOU have here the making of all Sorts of *Dials Arithmetically*, by *Artificial Sines*, and *Tangents*: And *Instrumentally* by a Ruler in p. 62 of the first Chapter; I think I need not tell you what the Ruler is, nor what Lines are upon it, for they are known to every one that understands the Letter that stands at the beginning of each Lines; and therefore I shall say no more of this Ruler as to the Description of it.

How to make an Equinoctial Dial.

Fig. 20.

Draw two Parallel Lines, as C, E, D, and A, F, B, and in the middle of the *Plane*, draw the *Perpendicular* FE, for the Hour of 12; then take from your Polar Scale (either of them will do) 1, 2, 3, 4, and 5 Hours successively one after another, and place from 12 on the parallel Lines, from E, and F, toward C, and D, and AB, and Lines drawn from one point to the other, are the Hour-lines required.

The Stiles Height is the distance between 12 and 3.

The

The Second PART.

CHAP. I.

Fig. 10

How to make a Polar Dial.

A *Polar-Dial* is a Dial that lieth upon the Equinoctial Circle, whose Stile or Axis is 90 deg. high, or (more properly speaking) is Perpendicular to the *Plane*, and is the easiest to be made of any Dial whatsoever; for the Equinoctial Circle being divided into 360 deg. one 24 part is 15 deg. or one Hour; this Dial being an *Horizontal Dial* under the Poles of the World, where the Sun is said to move equal Space in equal Time, but the Shadow in all other Places is Irregular.

Therefore the making of this Dial is nothing but dividing a Circle into 24 equal parts, and setting up an Iron Pin perpendicular to its *Plane*; your Dial is finished.

And this *Plane*, or *Dial* is capable of receiving all the 24 Hours, in the Latitude of 90 deg. Because the *Sun* keepeth continually moving round it, and round it again for the space of almost half a Year: And in all other Latitudes according to the length of their Days: So in our Latitude are put on all the Hours from 4 in the Morning till 8 at Night.

But the making of this *Dial* according to Geometrical Rule is laid down in Chap. 7. p. 21.

CHAP.

C H A P. II.

of Vetrical or Horizontal Planes, *Arithmetically.*

IN these Planes there is nothing required but the *Height of the Pole above the Plane*, which in all Places, is equal to the *Latitude of the Place*, for which the Dial is made.

First, Therefore prepare a Table, according to the Example adjoyning, wherein set down all the Hours in order from 12, as they are equidistant from the *Meridian*, viz. 11 and 1, 10 and 2, 9 and 3, 9, &c. unto them adjoyn the Equinoctial Distances, that is, for the first Hour 15 Degrees, for the second Hour 30 deg. for the 3d Hour 45 deg. and so of the rest, by continual addition of 15 deg. then take out of your Canon (or Tables) upon a loose Paper, the Logarithm or Artificial Sign of the Elevation of the Pole above this Plane, which for 51 deg. 30 min. The Height of the Pole here at London, is 9,893544, and is always one of the middle Proportionals, in finding out every Hours distance, apply it to 9,428052, the Logar. tangent of 15 deg. (which is the first Hours Equinoctial distance) and add them both together, there shall come forth a new Logar. tangent of 19,321596, for that Hours distance, which set down in the Table by 15 d. in the same place, remove your Paper, to the Logar. tangent of 30 deg. and add them both together, you shall produce a new Logar. Tangent of 19,893544, for the Hour of 2 and 10, which set down in the Table by 30 deg. work after the same manner

manner, with the Logar. Tangent of 45, 60, 75 deg. for the rest of the Hours.

Hours.	Equinoctial distances.	The Logarithm of the Tangents.	The new Logar. of the Tangents.	The true hour distances upon the Plane.
XII.	d ^o 0'	0	0	d ^o 0'
XI	I 15	0 9,428052	19,321596	11 50
X	II 30	0 9,761439	19,654982	24 12
IX	III 45	0 10,000000	19,893544	38 3
VIII	IV 60	0 10,138561	10,132105	53 36
VII	V 75	0 10,571947	10,465491	71 6
VI.	93	0 Infinite.	Infinite.	90 0

The Height of the Stile 51 deg. 30 min.

The Canon for Calculation is,

As the Sine of 90 deg.

Is to the Sine of the Latitude, 51 deg. 30 min.

So is the Tangent of 15 deg. (the *Equinoctial Distance* of one Hour of 30 deg. for two Hours of 45 deg. for three Hours, &c.

To the *Tangent* of 11 deg. 50 min. for 11 and 1—of 24 deg. 20 min. for 10 and 2—of 3 deg. 3 min. for 9 and 3, &c.

Now if you design to put into this Dial, or any of the rest that follow, the half Hours and Quarters, their Distances upon the Plane are as easily found by the same Rules, as the Hours were, for by adding the Log. Sine of the Height of the Pole, or Stile unto the Log. Tangents of

deg. 45 min. 7 deg. 30 min. and 11 deg. 5 min. which are the Equinoctial Distances of Half-Hours and Quarters, there will come forth the Log. Tangents of new Distances, proper to the Halfs and Quarters. *Note*, There is a Table of Equinoctial Distances for Hours, Halfs and Quarters in Page 31.

Note, Thus you have all the Hour-lines ; but for the Drawing of it take the Directions of the Chapter, in Page 15.

C H A P. III.

How to draw the Hour-lines upon a Direct South Dial in the Lat. of 51 deg. 30 min.

It is almost needless to say any Thing concerning the marking of a *Direct South Dial*, for there is but little Difference between it and the Horizontal, only you must take Notice that this Plane respecteth the *South Pole*, which Pole is elevated thereon 38 deg. 30 min. (always) the Complement of the *Latitude*, therefore take 38 deg. 30 min. out of your *Scale of Latitudes*, and finish your *Dial* in all Respects as you did the Horizontal: But observe, that whereas in that *Dial*, the Hours of 1, 2, 3, &c. were set off on your Left-hand of the *Meridian*, so the same Hours must in this *Dial* be set off on your Right-hand of the *Meridian*; if you well observe what was said in the IXth Chapter, Page 24.

Note, That the *Angle* which the *Stile* makes with the *Meridian*, must (as I have said before) be 38 deg. 30 min.

F

2. And

2. And Lastly, That the *Stile* must stand at right *Angles* with the Plane.

C H A P. IV.

Concerning a Direct North Dial.

A Direct North Dial, is the same with the South Dial, only the *Stile* must point upwards toward the North Pole, and the hours about Mid-night, 9, 10, 11, 12: 1, 2, and 3 must be left out, and 4 and 5 in the Morning, and 7 and 8 at Night must be drawn thro' the Center, as in the *Horizontal Dial*: So is your North Dial finished.

S E C T. I.

Fig. 17

How to draw an Horizontal Dial, for the Latitude of 51. 30. by the Scale of Latitude, and the Inclination of the Meridian.

1. **D**RAW the Line A B, for 6 a Clock Morning and Evening.
2. Draw NS, Perpendicular to A B; this Line shall be the Meridian, or 12 a Clock Hour-line.
3. Let C, the Intersection of the foresaid Lines be the Center of the Dial; then repair to your Scale of Latitudes, and fixing one Foot of your Compasses at the beginning, extend the other to 51 deg. 30 min. and set that from C to A, and from C to B, then open your Compasses the whole length of the line of Inclination, or the Scale of 90 deg. setting that extent one Foot in A, move the other till it meet with the Meridian-line N as at O, and draw the Line A O, and B O.
4. This done, extend your Compasses from the

beginning of your Scale of 90 deg. to 15 deg. and set from O towards A and B, for the Hours of 11 and 1, also from A towards O, for 5 a Clock, and from B towards O, for 7 a Clock. Then extend your Compasses from the beginning of your scale to 30 deg. and set from O towards A, and B, for the Hours of 2 and 10. Likewise from A towards O, for 4, and from B, towards O, for 6 of the Clock. Then take 45 deg. and set from O, toward A, and B, for the Hours of 3, and so you have 12 Points for Hours. Now Lines drawn from the Center C, to each of those Points shall be the Hours required.

Note, That the Hours of 4 and 5 in the Morning; and 7 and 8 in the Evening, must be drawn through the Center C; and if you design the halves and quarters of an Hour on your *Dial*, observe what was said in the last Chapter.

2. With a Line of Chord, make an Angle of 30. for the Stile of your *Dial*, and set it over the Meridian-line CO at Right Angle, and your *Dial* is finished.

C H A P. V.

Fig. 21.

How to draw Hour-lines upon a South or North Dial Declining either East or West to any Declination.

BEFORE the Hour-lines can be drawn upon any of those Planes two Things must be known, and three other Things must be found.

The Things given are,

1. The Latitude of the Place.

F 2

2. The

2. The *Planes Declination*,

The Things that must be found are,

1. The Substiles Distance from the *Meridian* or 12 a Clock Hour-line.
2. The Height of the Stile above the *Plane*.
3. The *Planes* difference of Longitude.

Example, Suppose that in the Latitude of *London* 51, 30, it were required to draw a *Dial* 25 deg. of *Declination Westwards*.

The Canon for Calculation are,

As the Radius ——— 90 : 00 — 10,00000

Is to the Sign of the *Declinat.* 25 : 00 — 9,62594So is the Co-Tang. of the *Lat.* 51 : 30 — 9,90060

To the Tan. of the Sub. dist. 18 : 33 — 19,52565

As the Radius ——— 90 : 00 — 10,00000

Is to the Co-sign of the *Decl.* 25 : 00 — 9,95727So is the Co-sign of the *Lat.* 51 : 30 — 9,79414

To the sign of the Stiles height, 34 : 21 — 19,75142

As the Radius ——— 90 : 00 — 10,00000

Is to the Co-Tang. of the *Dec.* 25 : 00 — 10,33133So is the Sign of the *Latitude* 51 : 30 — 9,89358

To the Co-Tang. of the *Planes* 30 : 47 — 10,22587
Long.

Hav

Having proceeded, thus far prepare a Table of Hours fit for the Plane, such as is here done.

Then against XII. set the Planes Differences of Longitude 30 deg. 47 min. (in the second Column) and from it subtract 15 deg. and there will remain 15: 47, which set against XI. and I. Then subtract 15 and there will remain only 47 min. which set against II. Then because 47 min. is less than

15 deg. write the word Substile under it, and subtract it from 15 deg. there will remain 14 deg 13 min. which set against IX and III. Then to 14 deg. 13 min. add 15 deg. it maketh 29: 13. which set against VIII and IV. Then add 15 deg. it maketh 44: ~~47~~¹³ which set against VII and V. Then add 15 and it makes 59: ~~47~~¹³ which set against VI. then 15 more makes 74: ~~47~~¹³ which set against V and VII, then 15 more makes 89: ~~47~~¹³, having finished your Table on this side of a Clock, I begin again at 12 and add 15 it makes 45: 47, which set against I. and XI.

<div>Hours on the Dial</div> <div><div>East</div><div>West</div></div>	Equi- noctial Distances.		True Hours distance from the Substile.	
	D.	M.	D.	M.
III. IX.	75	47	65	49
II. X.	60	47	45	16
I. XI.	45	47	30	07
XII.	30	47	18	33
XI. I.	15	47	09	04
X. II.	00	47	00	02
Substile	Substile		Substile	
IX. III.	14	13	08	08
VIII. IIII.	29	13	17	31
VII. V.	44	13	28	47
VI.	59	13	43	27
V. VII.	74	13	63	24
IV. VIII.	89	13	88	37

and 15 more makes 60 : 47 which set against II and X, and 15 more makes ~~72~~ 47, which set against III and IX. And thus you have made a Table fit for Calculation, viz. for finding the true Hour-distances on the Plane.

The Canon for Calculation is,

As the Radius, — — — 90:00-10,000000
Is to the sign of the Stiles height, 34:21- 9,751469
So is the *Tan.* of the *Equi.* dist. 14:13- 9,403718

To the *Tangent* of, — — — 08:08-19,155187

Which is the Distance of 9 and 3 of the Clock from the Substile.

And so will the *Tangent* of the next *Equinoctial* Distance, 29 : 13, be to the *Tangent* of 17:31, for the Distance of the Hour-line of 8, and 4, from the Substile, and so for all the rest of the Hours, as in the Table.

Having calculated all your Hours, you have Directions for describing them on the Plane by Chap. V. Page 19.

S E C T. I.

How to draw Hour-lines on South or North Declining Planes by your Line of Latitude and Inclination of Meridian on your Ruler in Page 62.

An Example of the foregoing Dial, Decl. 25 deg.

HAVING calculated your Requisites belonging to your Dial, and made a Table of
Equi-

Equinoctial Distances, according to the former part of this Chapter, you will find them to be as followeth,

To draw the *Dial*.

1. Draw an *Horizontal* Line on the *Plane*.

2. Draw C 12, the *Meridian*, or 12 a Clock Hour-line, perpendicular to the *Horizontal*-line of your *Plane*, and with a Line of Chords make the Angle F C 12. equal to the Substile distance from the *Meridian*, and draw C F for the Substile on the right-hand of the *Meridian* because the *Plane declines West*.

3. Draw the Line A B, perpendicular to the Substile, and passing thro' the Center at C, then out of your line of *Latitude* take 34 : 21 (the height of your Stile) and set it from C to A, and

from C to B, then take in your Compasses the whole length of your Scale of *Inclination* of *Meridian*, and set one Foot in A, and turn the other about till it will touch the Substilar line, as at F, and draw the Line F A, and F B.

4. Then repair to your Table, and take off your Scale of *Inclination* of *Merid.* 15 deg. 47 min.

F 4

39,

<i>Latitude.</i>	51—30
<i>Pl. Decli.</i>	25—00
<i>Sub. Dist.</i>	18—33
<i>Stiles Hei.</i>	34—21
<i>Plan. Long.</i>	30—47

<i>Hours.</i>	<i>Equinoct</i>	
	<i>D.</i>	<i>M.</i>
IX.	75	47
X.	60	47
XI.	45	47
XII.	30	47
I.	15	47
II.	00	47
Sub-	stile.	
III.	14	13
IV.	29	13
V.	44	13
VI.	59	13
VII.	74	13
VIII.	89	13

30 : 47, 45 : 47, 60 : 47, 75 : 47, and set from F the Substile towards A, for the Hours of 2, 12, 11, 10, and 9 of the Clock; again take 13, 29 : 13, 44 : 13, 59 : 13, 74 : 13, and 89 : 13, and set from F, towards B, for the Hours of 3, 4, 5, 6, 7 and 8: *Note*, 8 falling above the *Horizontal-line*, is drawn thro' the Center for use in the Morning, as you see in the Figure.

5. Let your Hour-lines be drawn from the Center thro' every mark in the Line FA, and FB, and your Stile set on the Substile, making an Angle of 34 : 21, and your Dial is finished.

S E C T. II.

How by the Heighth of the Stile, the Declination of the Sun, to find what Time the Sun shall part, from one side of a Declining Plane to the other.

The Canon for Calculation.

As the Radius,	— —	90 : 00 — 10,0000
Is to the <i>Tang.</i> of the <i>Sun's Decl.</i>	23 : 30 —	9,6389
So is the <i>Tang.</i> of the <i>Stiles hei.</i>	34 : 21 —	9,8346
To this Co-sine, <i>viz.</i>	72 : 43 —	19,4729
From which Subtract	— —	30 : 47
the <i>Planes Long.</i>	— — —	— — —
And there remains,		41 : 56

Which 41 : 56 resolved into Time (by allowing 15 deg. to one Hour, and the odd deg. min. of Time,) maketh 2 Hours 48 min. After noon, that the *Sun* forsaketh the *South Dial* Declining

Declining East, to shine upon the North Dial Declining West: So by the same Calculation the Sun forsaketh the North Declining East 2 Hours 48 min. before Noon, to Shine upon the South Declining West.

Again the Sun being in vs, the Southern Sine

into	—	—	—	—	—	—	—	72—43
Add the Planes Longitude	—	—	—	—	—	—	—	30—47
								<hr/> 102—90

The Sum is,	—	—	—	—	—	—	—	103—30
-------------	---	---	---	---	---	---	---	--------

Whose Complement to 180 deg. is, 76—30

Which converted into Time is 5 Hours 6 min. for the Time in Capricorn, when the Sun passeth from one side of the Plane to the other, between which two Limets the Annual Variety of the Sun is concluded.

Lastly, In the making of this Dial you have made Four, viz. First a South Declining West 25 deg. but if you turn your Paper and look thro' it, it will on the Back-side be a South Declining East, 25 deg. Only the Afternoon Hours on the West Dial, must be the Morning Hours on the East, and if you turn your Dial the Bottom upwards, and reckon your Hours the contrary way: So a South East Decliner, will be a North East Decliner, and a South West Decliner, will be a North West Decliner, leaving out the Hour-lines (which will be needless) before the Sun-setting, and after the Sun-rising.

Note, That the Substile in all Decliners, goeth from the Meridian towards that Coast, which is contrary to the Coast of the Planes Declination.

C H A P. VI.

Fig.

How to draw Hour-lines upon a Far Declining Dial, by the two Polar Scales on the Ruler.

Example of a South Dial Declining East 80 deg. the Latitude of 51 deg. 30 min.

BY the Directions of the last Chapter (or Page 26) you shall find the Inclination of the *Meridian* to be 82 deg. 9 min. and the Height of the *Stile* above the Plane 6 deg. 1 min. and the *Substile's* Distance from the *Meridian* 38 deg. 4 min.

Proceed thus, draw first, the Perpendicular GH then with the *Radius* of your Line of Chords, describe the Arch LM, and set off the *Substile* and *Stile* with the same Line of Chords, according to their respective Angles, and draw the prick'd line CBA for the *Substile*; and GIK for the *Stile*.

Then choose any point in the *Substile*, as A, through which Point A, draw a Line at length Perpendicular to it, as the Line EAC, that done fix one Foot of your Compasses at the beginning of your longest *Polar Scale*, and extend the other to the Hour of 3, set off this extent from A to C, and through the Point C draw a Line Parallel to the *Stile* GIK, as the Line CD, so shall CD be the *Stile* increased. Then open your Compasses from the beginning of your second or lesser *Polar Scale*, to 3 Hours, and with that extent, place one Foot of your Compasses in the *Substile* ABG, carry-

ing

g it along the said Line, until the other Foot of the Compasses just touch the Line CD, and there make a mark, as at B, through which mark B, draw a Line at length, and Parallel to the Line AC, as the Line DBF. Then considering the Inclination of the *Meridian* was found to be 82 deg. 9 min. find it on the first *Scale*, or *Scale* of 6 deg. and against it on the first *Scale* you shall find 5 Hours 29 Minutes, by which it appears that the *Substile* falleth between the Hours of 6 and 7 in the Morning.

Now according to the Inclination of *Meridians* 5 Hours 29 Minutes, you may proceed to make a Table, and set off the Hours accordingly, as followeth.

Open your Compasses too 00 *Hours* 29 min. of the Greater *Polar Scale*, and set it for the Hour 7, in the Line EAC. Then open the Compasses to 1 Hour 29 min. of the same *Scale*, and set it from A to 8. Then open your Compasses to 2 *Hours* 29 min. and set it from A to 9. Then open your Compasses to 3 *Hours* 29 min. and set it from A to 10. Lastly, Open the Compasses *Hours* 29 min. and set it from A to 11.

Now having found the Points for the Hours on one side of the *Substile* from A towards E, you must do the like for the other *Hours* on the other side of the *Substile*: And considering that the first Hour from the *Substile* towards E, namely, A contains the Distance of 00 *Hours* 29 min. as by the following Table; the Complement thereof to 60 min. or an *Hour*, is 00 *Hours* 31 min. as the said Table appears.

Table

From A towards E.			From A towards C.		
H.	M.	H. on the Plane.	H.	M.	H. on the Plane.
0	29	A	7	0	31 A
1	29	A	8	1	31 A
2	29	A	9	2	31 A
3	29	A	10	3	31 A
4	29	A	11	4	31 A

Proceed to set off 00 *Hours* 31 min. taken from the same *Polar Scale* from A to the *Hour* of 5, and extend your *Compasses* from the beginning of the *Scale* to 1 *Hour* 31 min. and set it from 5, also to 2 *Hours* 31 min. and set it from A to 4, also to 3 *Hours* 31 min. and set it from A to 3; and lastly, The extent of the *Compasses* from the beginning of the *Scale* to 4 *Hours* 31 min. set off from A to 2, and so you have *Points* for the *Hours* on the *Plane* on the *Line* CAH.

Now for the other *Line* DBF, you must set off the *Hours* thereon (taken out of the *lesser Polar Scale*) from B both ways according to the *Table* in all *Respects* as you did set off the *Hours* from A. This being done, draw *Lines* through the respective *Points* found in the *Lines* CAH, and DBF, and those *Lines* shall be the *Hour-lines* for this *Dial*.

The *Stile* must be a thin *Plate* of *Brass* or *Iron*, and stand directly over the *Substile*, as in the *Figure* is demonstrated, by AB and CD.

Thus have you finished your *Dial*, and in the making of this you have made a *South Declining*

W

st 80 deg. Also, for if you turn the Paper, and look through it, it will on the back-side appear *Declining West* 80 deg. only the Forenoon Hours in this, must be the Afternoon *Hours* in that : say, in rigour, you have in this one Dial made for, a *North Declining*, either *East* or *West*.

C H A P. VII.

Fig. 18.

How to draw Hour-lines upon a direct East-Dial, Arithmetically.

Let there be an *East-Dial*, whose breadth is 6 Inches ; and it is required to put on all the Hour-lines from 6 in the Morning till 11 at Noon ; here you have 5 Hours and 6 Inches : Therefore, before you can work the Operation, you must turn the Hours into Degrees, by allowing for every Hour 15 Degrees, so you will have 75 Degrees for 5 Hours ; then turn the Inches into Parts, by allowing 100 Parts to every Inch, so you will have 600 Parts.

I. For the Height of the Stile.

As the Radius 90	10.00000
Is to the <i>Tangent</i> of 5 Hours 75 deg. com. A.	9,42805
So is the Log. of the distance from 6, 600 parts	2,77815

To the Log. of the Stiles height, in Parts 161.	12,20620
---	----------

That is, 1 Inch, 61 Parts of an Inch, an Inch divided into 100 Parts.

As

II. For the Hour-lines distance from VI.

7.	{ As the Radius 90.		10,0000
	{ Is to the Log. of the Stiles height 161.		2,2068
	{ So is the Tangent of 15 deg. for 7 a Clock		9,4234
	{ To the Log. of the first Hour 43 Parts,		11,6344
8.	{ As the Radius 90.		10,0000
	{ Is to the Log. of the Stiles height 161.		2,2068
	{ So is the Tangent of 30 deg. for 8 a Clock,		9,7614
	{ To the Log. of the 2d Hour 43 Parts.		11,9682
9.	{ As the Radius 90.		10,0000
	{ Is to the Log. of the Stiles height 161.		2,2068
	{ So is the Tang. of 45 deg. for 9 a Clock,		10,0000
	{ To the Log. of the 3d Hour, 161 Parts.		12,2068
10.	{ As the Radius 90		10,0000
	{ Is to the Log. of the Stiles height 161.		2,2068
	{ So is the Tang. of 60 deg. for 10 a Clock.		10,2385
	{ To the Log. of the 4th Hour, 279 Parts.		12,4433
11.	{ As the Radius 90		10,0000
	{ Is to the Log. of the Stiles height 161.		2,2068
	{ So is the Tang. of 75 deg for 11 a Clock,		10,5719
	{ To the Log. of the 5th Hour, 600 Parts.		12,7787

Having thus far proceeded, that 5 Hours from 6 is calculated, namely, 7, 8, 9, 10, 11, there are yet 4 and 5 in the Morning that must be drawn the same distance from 6 in the Morning, as 7 and 8 are; therefore for your better Instruction, see the following Dial, and imitate this Geometrical Construction.

First, Square out your Dial, and draw the Line D, A, C, towards the bottom of your Plane; then with 60 degrees of Chords in the Point C, on the edge

I. Edge of the Dial, describe a part of a Circle as
 , B, and set from A, to B, the Complement of
 your Latitude $38^{\circ}.30'$ and draw the Line CBF,
 thro' the Plane for the Equinoctial.

Secondly, Have Recourse to your Table, and
 take, in your Compasses, the distance in Parts
 between 6 of the Clock and 11 namely 600, and
 make Marks with both Feet in the Equinoctial
 for the Hour-lines of 6 in the Morning, and 11,
 but remember to leave room above 6, for 4 and
 in the Morning, then take in your Compasses
 3 Parts, and set from 6, to 7, and 5, then take
 in your Compasses 93 Parts, and set in the Equa-
 tor or Equinoctial, from 6 to 8 and 4; then take
 in your Compasses 161, and set in the Equinoctial
 from 6, to 9: Lastly, Take 279 Parts, and set in
 the Equinoctial from 6 to 10, and thro' the
 points in the Equinoctial draw Perpendiculars,
 and they shall be the true Hour-lines.

Note, The Stile must be the breadth of 6 and
 of the Clock, as you see in the Figure, and
 must stand perpendicularly in the Hour-line of
 of the Clock.

IV.	093
V.	043
VI.	000
VII.	043
VIII.	093
IX.	161
X.	279
XI.	600

Note, If you have
 a Mind to draw
 the Quarters and
 Half Hours, and
 Three Quarters,
 you may, if you
 observe what was
 said in Ch. 2. P. 65.



S E C T. I.

Fig. 1

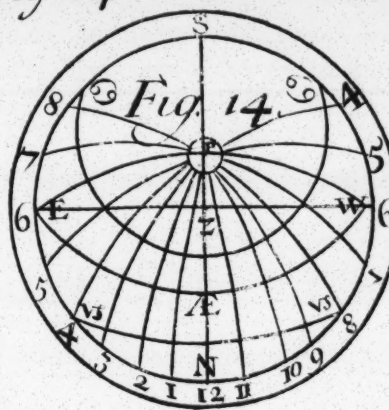
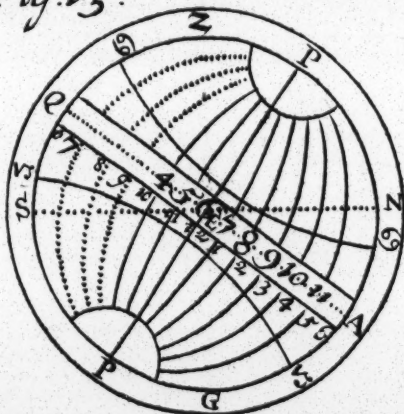
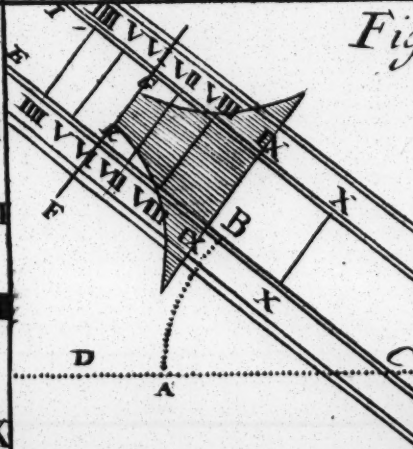
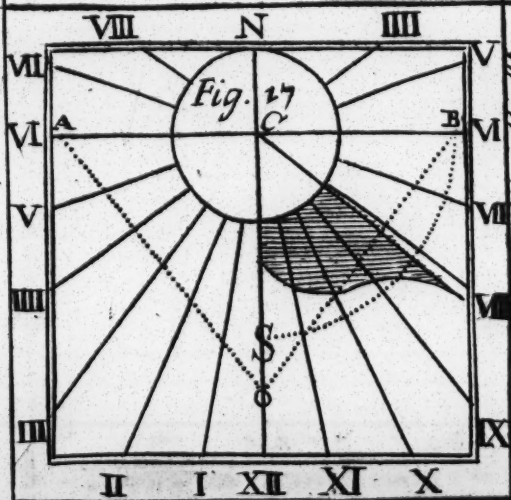
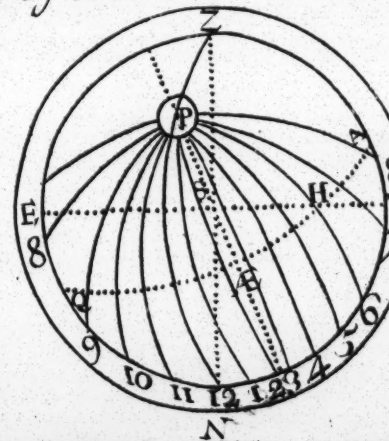
How to draw the Hour-lines, upon a Direct East or West Dial instrumentally by the Polar Scale

1. **U**PON the Point C, if it be an *East-Dial* or upon the Point D, if a *West*, with 38° deg. of your Line of Chords, draw an obscure part of a Circle as AB, and in that Arch from A to B, set off the *Height* of the *Equinoctial*, 38° deg. 30 min. and draw the Line CDE, then in some convenient Place of the Line CE, as at R, draw the Line GRF, at right Angles to the Line EDC so shall GRF, be the Substile and Hour-line of 12 .

2. Draw IH, parallel to the Line EDC.

3. Repair to either of your *Scales* known by the Letters [*Pol.*] and fix one Foot of your Compass at the beginning of the said *Scale*, and extend the other Foot to the Hour of 1 . Set off that extent from G to 5 , and from G to 7 , and on its parallel EC, from R both ways, and draw the Hours of 5 and 7 parallel to the Substile and Hour-line of 12 . Then take in your Compasses the distance from the beginning of the *Scale* to 2 hours, and set it off from G to 4 , and from G to 8 , and also from R both ways, and draw the hour of 4 and 8 parallel to the other; so you have now more hours to set off towards I, being 4 is the hour of Sun-rising; but proceed to set off the rest of the hours towards H, as you did the other hours, taking in your Compasses the distances from the beginning of the *Scale* to 3 , 4 , and 5 , and setting each distance off respectively from G towards H, at 9 , 10 , 11 , and 12 .

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*Fig. 14.**Fig. 15.**Fig. 16.*

o from R towards C, and draw the hours of 10, and 11: And so you have all the hours proper for an *East-Dial*.

4. And lastly, The distance from the beginning the Scale to the hour of 3, gives the height of Stile, which must stand directly over the *Hour* of 6, make Right-Angles therewith, and may be made of a thin Plate of Iron or Brass, or a sharpned, whose Extremity must give the shadow to the *Hour-lines* on the *Dial*.

Note, That if you turn the *East-Dial* drawn on paper from you, and look on the back-side, you will see the perfect Form of a *West-Dial*, only read of the hours 11, 10, 9, 8, 7, 6, 5, 4, must write 1, 2, 3, 4, 5, 6, 7 and 8.

C H A P. VIII.

How to find the Reclination of any Plane.

TAKE a *Quadrant* and joyn it to the side of a *Square*, and place the other side of your *Square* to the *Plane*; if the *Plummet* fall Parallel to the side of the *Square*, then the Lower-side of the *Square* stands level, by which draw a *Horizontal-line*, on which erect a *Perpendicular*, and apply your *Square* to that *Perpendicular*, and if the *Plummet* falls parallel to the side of the *Square*, then that is also a *Level-line*, and your *Square* stands *Horizontally*: If the *Plummet* falls Parallel to the side of the *Square*, then turn the *Square* until it does, then draw an *Horizontal-line*, on which erect a *Perpendicular* to which apply

apply your *Square*, and observe what Angle your Plummets makes on the *Quadrant*, with the side of the *Square*, that is the Angle of the *Reclination* of the *Plane*.

C H A P. IX.

Fig. 18

Of *direct East or West Reclining Dials*, and how their *Hour-lines* may be described upon them.

[**A**S all *Direct North and South Reclining Dials* are reduced to *New-Latitudes*, where they would be *Horizontal Dials*; so all *Direct East or West Reclining Dials*, in any one Latitude may be reduced to *Upright Declining Dials* in another Latitude.

Definition.] An *East or West Reclining Dial*, is a Dial that directly beholds the *East or West*, and *Recline* or fall back like the *Roof* of an *House*.

S E C T. I.

To reduce any *East or West Reclining Dial*, in any Latitude, to a *New-Latitude*, where the *Reclining Dial* shall become an *Upright Dial*, and what *Declination* that *Upright Dial* shall have in that *New-Latitude*.

Example.

Suppose then, that a *direct East*, or *West Dial* in the Latitude of *London* $51-30$, should recline from the *Zenith* 35 deg. in what Latitude will that be an *Upright Dial*? And what *Declination* shall it have in that Latitude?

R U L E

R U L E.

The Complement of the known Latitude, is (always) the New-Latitude; and the Complement of the Reclination is (always) the Declination in that New-Latitude.

So that if an *East* or *West* Dial should recline 35 deg. in the Latitude of 51—30, that will be an Upright Dial, Declining 55 deg. in the Latitude of 38—30.

For 38:30. being the Complement of 51:30, is the New-Latitude. And 55 deg. being the Complement of 38:30 deg. the Dials Reclination is the Declination in that New-Declination.

The Canons for Calculation are,

I.

As the Radius	90,00—10,00000
Is to the Sign of the Decli.	55:00— 9,91336
So is the <i>Co-Tang.</i> of the <i>Lat.</i>	38:30—10,09939
	<hr/>
To the Tan. of the Sub. dist.	45:52—10,01275
	<hr/>

II.

As the Radius	90:00—10,00000
Is to the Co-sign of the Decli.	55:00— 9,75859
So is the Co-sign of the <i>Lat.</i>	38:30— 9,89344
	<hr/>
To the sign of the Stiles height,	26:41—19,65213
	<hr/>

III.

As the Radius, 90:00—10,00000
 Is to the Co-Tang. of the Decl. 55:00— 9,84522
 So is the Sign of the Latitude. 38:30— 9,79415

To the Co-Tan. of the Planes } 66:27—19,63937
 Long. }

<i>West</i>	<i>East</i>	<i>Equinoctial Distances.</i>		<i>True Hours on the Plane.</i>	
		<i>H.</i>	<i>M. D.</i>	<i>M. D.</i>	<i>M.</i>
10	02	83		33	50
09	03	68		33	49
08	04	53		33	18
07	05	38		33	41
06	06	23		33	04
05	07	08		33	52
<i>Substile.</i>					
04	08	06		27	54
03	09	21		27	00
02	10	36		27	21
01	11	51		27	24
12	12	66		27	52
11	01	81		27	29

Havin

Having calculated the *Requisites*, and made the Table after the manner of a declining Dial; and the Hour Arches calculated, we proceed to the Geometrical Projection of a West Recliner.

Draw the Line A,D, for the Horizontal-line of your reclining Plane; then at a convenient distance, and Parallel to the Line A,D, draw the Line G, O, 12, for the 12 a Clock Hour-line, and making G, the Center of your Dial, with 60 deg. of Chords, in G, describe the Circle O,R, p,d, and from O, to R, set the Substiles distance from the *Meridian* 45, 52 min. and from R to p, set 26, 41 the Stiles height, and draw R,G, for the Substile, and p, G, for the Stile; then take out of your Table 03:52, 11:04, 19:41, 31:18, 48:49, 75:50, and set from R, the Substile, for the hours of 5, 6, 7, 8, 9, and 10; likewise take 02:54, 10:00, 18:21, 29:24, 45:52, 71:29, and set for the hours of 4, 3, 2, 1, 12, 11, and thus you have all the hours as you see in Fig. 19.

S E C T. II.

How to draw this Dial by the Line of Latitude and Scale of Inclination of the Meridian.

HAVING found the Equinoctial Distance as before, and drawn the Horizontal-line, the Hour-line of 12, and set off the Substiles distance and Stiles height, proceed after this manner: Draw a Line perpendicular to the Substile, passing thro' the Center, as at G, and take off your line of Latitude 26 deg. 41 min. and set from G to a, and B; then take the length of the whole Scale

G 3

of

of the Inclination of the *Meridian* in your Compasses, and set one Foot in *a*, and turn the other about till it touch, or cross the Substile as at *b*, and draw the Line *b, a*, and *b, b*, then repair to your Table of Equinoctial Distances, and take off your Scale of Inclination of *Meridian* 06:27, 21:27, 36:27, 51:27, 66:27, 81:27, and set one after another on the Line *b, a*, from *b* towards *a*, for the hours of 4, 3, 2, 1, 12, and 11 of the Clock, then take 08:33, 23:33, 38:33, 53:33, 68:33, 83:33, and place from *b* towards *b*, for the hours of 5, 6, 7, 8, and 9, of the Clock.

Note, That ~~the~~ of the Clock is to be drawn thro' the Center for the hour of 10 in the Morning, because the Sun shineth not in our Latitude but 13 min. after 8 at Night.

And thus you have at one Work made 4 Dials, viz. a *West Recliner* and an *East Recliner*, and a *West Incliner* and an *East Incliner*, for if you turn the Dial the bottom upwards, the Center will be Northwards, and the *Axis* point Southwards, and those Hours, viz. 3, 4, 5, 6, 7 and 8, will be the Afternoon-hours of a *West Inclining Dial*; and if you observe the same of the *East Reclining Dial*, it will produce the *East Inclining Dial*.

Note, In the making of the *East Reclining Dial*, your Center must be on the Left-hand side of the Plane, and the hours run the other way, as you may see if you turn your Dial, and look thro' the back-side of it.

S E C T. II.

The Height of the Stile, the Declination of the Sun, and the Reclination of the Plane given, to find what Time the Sun forsaketh the East or West Reclining Dial, and shineth on the opposite Incliner.

Definition.

THE Planes of *East* and *West* Recliners or Incliners lie in the Circle of Position, denominating their Inclination; and to find the Time the *Sun* forsaketh the one to shine upon the other, observe this general Canon.

As the Radius	90.	10,00000
As to the <i>Tang.</i> of the <i>Sun's</i> Decl.	23:30	9,63839
As to the <i>Tang.</i> of the <i>Stiles</i> height.	26:41	9,70120
To the Co-sine of	77:22	19,33950
To which add the Planes <i>Lang.</i>	66:27	—————
And the Sum is	143:49	—————
Whose Complement to 180 is	36:11	

Which 36:11 resolveth into Time, by allowing 15 deg. to an hour, and to every odd deg. 4 min. giveth 2 hours 24 min. after Noon when the *Sun* (in *Cancer*) forsaketh the *East* Reclining Dial 35, and illuminateth the Opposite, the *West* Inclining Dial, or it giveth 2 hours 24 min. before Noon, when the *Sun* parteth from the *East* Reclining Dial, and shineth upon the *West* Inclining Dial.

Note, That upon all *East* and *West* Recliners in the *Northern Hemisphere*, the *North-Pole* is elevated; and on their opposite Incliners the *South Pole*.

Note, The *Meridian* upon all *East* and *West* Reclining Dials, lies parallel to the *Horizon*.

C H A P. X.

How to draw the Hour-lines upon Direct South and North Reclining Dials.

SUCH Planes as do directly behold the $\left\{ \begin{array}{c} \text{North} \\ \text{South} \end{array} \right\}$ Point of the *Horizon*, but *Reclining* (or fall backward) from the *Zenith* towards the $\left\{ \begin{array}{c} \text{South} \\ \text{North} \end{array} \right\}$ are called $\left\{ \begin{array}{c} \text{North} \\ \text{South} \end{array} \right\}$ *Direct* Planes *Reclining*: So many Degrees as the *Reclination* is: And of such *Planes* there are six *Varieties*; Three of *South*, and Three of *North Recliners*: All which may be reduced to *New-Latitude* wherein they will become *Horizontal Planes*: And consequently *Dials* (or *Hour-lines*) may be described upon them by the *Precepts* delivered in *Chap. I. page 15*.

1. Of South Recliners.

Examples of all these *Varieties* of *Reclining Planes*, in the *Latitude* of *London* 51 deg. 30 min to find the *New-Latitude*.

1. Variety. Let there be a *Direct South Plane*

the *Latitude* of *London*, which reclines from the *Zenith* thereof 20 deg. In what *Latitude* will that be an *Horizontal Plane*? The *Planes* declination 20 deg. being less then 38 deg. 30 min. the Complement of the *Latitude* of *London*, Subtract 20 deg. from 38 deg. 30 min. the Remainder (or difference) 18 deg. 30 min. is the New ~~Latitude~~ *Longitude*. So that an *Horizontal Dial* made for that *Latitude* shall be a *South Reclining* 20 deg. in the *Latitude* of *London*.

2. Variety. If a *South Plane* in the *Latitude* of 51 deg. 30 min. should recline 60 deg. from the *Zenith* thereof : In what *Latitude* will that be an *Horizontal-Plane*?

The *Reclination* of the *Plane* 60 deg. being greater then 38 deg. 30 min. the Complement of the *Latitude* of *London*, Subtract 38 deg. 30 min. from 60 deg. and the Remainder 21 deg. 30 min. is the New-*Latitude* : And an *Horizontal-Dial* made for that *Latitude* of 21 deg. 30 min. shall serve for a *South Dial Reclining* 60 deg. in the *Latitude* of *London*.

3. Variety. If a *South-Plane* in the *Latitude* of *London* should recline from the *Zenith* thereof 38 deg. 30 min. Equal to the Complement of the *Latitude* of *London*. Then,

The difference between the Complement of the *Latitude* of *London* and the *Reclination* being nothing ; it shews the New-*Latitude* to be no *Latitude*, that is neither Pole hath any Elevation over such a *Plane*, but is an *Equinoctial Plane*, and must be made by the Rules delivered in the 6th Chapter of this Book, or by Page 61.

2. Of

2. Of North Recliners.

1. Variety. If a *North-Plane* in the Latitude of $51^{\circ} 30'$ should recline from the *Zenith* 20° . In what Latitude will that be a *Horizontal-Plane*?

The Reclination 20° . being less then the Complement of the Latitude of *London*, $38^{\circ} 30'$. add the Reclination 20° . and the Latitude $38^{\circ} 30'$. together; their Sum $59^{\circ} 30'$. is the New-Latitude: And a *Horizontal-Dial* for that shall be a *North-Plane Reclining* 20° . in the Latitude of $51^{\circ} 30'$.

2. Variety. If a *North-Plane* in the Latitude of *London*, $51^{\circ} 30'$. should recline from the *Zenith* 75° . In what Latitude will such a Plane be *Horizontal*?

The Reclination 75° . being greater than $38^{\circ} 30'$. Add them together and they make $113^{\circ} 30'$. which being above 90° . take the Complement thereof to 180° . which is $66^{\circ} 30'$. And that is the New-Latitude. So that an *Horizontal-Dial* made for the Latitude of $66^{\circ} 30'$. will be a *North-Plane Reclining* 75° . in the Latitude of *London* $51^{\circ} 30'$.

3. Variety. If a *North Plane* in the Latitude of *London* $51^{\circ} 30'$. should recline from the *Zenith* thereof $51^{\circ} 30'$. In what Latitude will such a Plane be *Horizontal*?

Here the Reclination $51^{\circ} 30'$. is equal to the Latitude of *London*; and the Sum of the

ination 51 deg. 30 min. and the Complement of the Latitude 38 deg. 30 min. Add together their Sum is 90 deg. for the New-Latitude: an Horizontal Dial made for that Latitude 0 deg. will be a *North Plane Reclining* 51 deg. min. of the Latitude of *London*, and must be by the Rules delivered in the 30th Chapter in this Book.

Note, That upon all *South Reclining Direct* Dials, if the *Reclination* be less than the Complement of the Latitude, the *South-Pole* is elevated; and equal to the Complement of the Latitude, neither Pole is elevated, but is an *Equinoctial*, and made by Chap. VI. And if more than the Complement of the Latitude, the *North-Pole* is Elevated, and the Center of the *Dial* is at the bottom. from upon the *North* Inclining less than an *Equinoctial*, the *North-Pole*, equal to an *Equinoctial*, neither Pole, and more than a *Equinoctial* the *North-Pole*.

Note, 2. That upon all *North Direct Reclining* Dials, the *North-Pole*; and on all *Direct Inclining* Dials, the *South-Pole*.

S E C T. I.

Height of the Stile, the Declination of the Sun, and the Reclination of the Plane given, to find what Time the Sun shall forsake a North Inclining Plane, to shine upon a South Reclining Plane, opposite thereto.

There is six Varieties of *North and South Reclining and Inclining Dials* — And first of the

the three *South*, I. In that which reclines 20 being less than an Equinoctial, there are given the height of the Stile 18 deg. 30 min. the Declination of the Sun 23 : 30, to find at what Time the Sun forsaketh the *North* Inclining Plane and shine upon the aforesaid *South* Reclining 20

As the Radius,	—	—	90 00	10,00
Is to the <i>Tan.</i> of the Sun's Decl.	23	30	9,6	
So is the <i>Tan.</i> of the Stiles heig.	18	30	9,5	
To this Co-sine,	—	—	81 38	19,16

Subtract this 81 : 38, out of 90 deg. there remain 8 deg. 22 min. which converted into Time giveth 34 min. before 6 in the Morning, and at Night, when the Sun in Cancer departeth from the Inclining side of the Plane, and shine on the Reclining and contrary.

2. Of that which reclines to the Pole, or equal to the Complement of the Latitude; this Sun lyeth in the fix a Clock Hour-Circle, and therefore the Case is plain, that the Sun always passeth from one side the Flat to the other just at Six the Clock; and from the 13th of *September*, the 10th of *March* (or the Sun's abode in *Southern* Signs) the Sun shines not at all upon the reclining side.

3. In that which Reclines 60 deg. being more than an Equinoctial; there are given the height 21 : 30, the Sun's Declination 23 : 30, to find at what Time the Sun parteth with the

ining Dial, to shine on the *South Reclining*
posite thereto.

the Radius,	90 00	10,00000
to the <i>Tan.</i> of the <i>Sun's Decl.</i>	23 30	9,63830
is the <i>Tan.</i> of the <i>Stiles</i> heig.	21 30	9,59539
this Co-sine,	80 08	<u>19,23369</u>

subtract this 80 : 08, out of 90, and their will
main 09 : 52, which converted into Time giv-
00 hours 39 min. before Six a Clock in the
orning, and after six at Night, when the *Sun*
Cancer departs from the Inclining side to illu-
minate the opposite Recliner, and contrary. And
as may you be satisfied for any other Declina-
tion of the Sun whatsoever.

S E C T. II.

Height of the Stile, the Declination of the
Sun, and Reclination of the Plane being gi-
ven, to find what Time the Sun forsaketh the
North Reclining Dial, to shine upon the
South Inclining Dial.

N North Direct Recliners, there are three
Varieties which shall be spoke of as fol-
loweth.

1. Of the *North Reclining* 20 deg. This Dial
during the *Sun's* Southern Declination, it only
shines upon the Inclining side: But during his
mode in the Northern Sines, some part of the
Day,

Day on the Reclining side, and some part of
Inclining side; whose Quantity of time is
by the following Proportion.

As the *Radius* — — — — 90.00. 10.

Is to the *Tang.* of the Sun's decl. 23.30. 9.

So is the *Tang.* of the Stile height, 58.30. 10.

To this Co-sine of — — — — 44.48. 19.

Which 44.48, resolved into time, gives
hours 59 min. before, and after Noon, when
Sun in *Cancer* forsaketh, and returneth again
the reclining part of the *Plane*.

2. Of the North Reclining 51.30. being
lar Dial: This Dial lying in the Equinoctial
Circle, hath the Sun during his abode in the
Northern Sines, shining only on the reclining
and the Sun in the *Southern Sines* shines upon
Inclining Dial.

3. Of the North Reclining 75 deg. being
than a *Polar*: This Dial, during the Sun's
in the Northern Sines, hath the Sun only
on the Reclining Dial; the rest of the Year
shineth upon both (whose time is easily found
the Declination) until the *Meridional* rectitude
the Sun from the *Zenith* (or the *Zenith* distance
which is all one) be greater than the Reclination
of the *Plane*, and then it shineth only upon
Inclining *Plane*.

To find the time of the Year for that, Set
the *Reclination* of the Equinoctial 51.30. to the
the *Reclination* of the *Plane* 75, and then

main 23.30. the Declination of the Parallel in
 which the Plane lieth, which is the first degree
 Capricorn, (as you will find by Calculation)
 at that time which is the 10th of December,
 the Sun forsaketh the Reclining Plane to shine
 only on the Inclining Dial, as you will find by
 the following Proportion.

the Sine of the Sun's Decl. 23.30. 9. 60069

 to the Radius ———— 90.00. 10.00000
 is the Sine of the Difference 23.30. 9. 60069

this Sine ———— 90.00. 10.00000
 Which is the third Sign from *Libra*, namely
 Capricorn, (as I said before) when it forsaketh
 the reclining Dial, to shine only upon the Inclining
 Dial, and so continues till it ascends again to
 Cancer, which is the Parallelisme with it, which
 the 10th of June.

I have chose this Dial, reclining 75 deg. be-
 cause the Operation, or Working, may seem dif-
 ficult, because the first term 23.30, which must
 always be subtracted from the third, (which is
 30,) the remainder is 90.00.

I shall here give you the Working of the Canon
 a Dial reclining but 70 deg.

Example.

the sine of the Sun's Decl. 23.30. 9. 60069

 to the Radius — — — 90.00. 10.00000
 is the sine of the Difference, 18.28. 9. 50072

 this sine 52.33. 9. 89973

Out

Out of $52:33$, subtract 30 deg. for the sine *Libra* there will remain 22.33 , of *Scorpio* for the place of the Sun, when it forsaketh the reclining *Dial* to shine only on the Inclining *Dial*, till it ascend again into $07:27$, of *Aquaries*, which is in Parallelisme with it, by this place of the Sun every Almanack will shew the time of the Year.

Note also, That in making of any of these North or South, reclining *Dials*, you have made also Direct North or South *Dial* inclining from the Zenith towards the Horizon, so many Degrees

as the $\left\{ \begin{array}{l} \text{Recli-} \\ \text{Incli-} \end{array} \right\}$ nation.

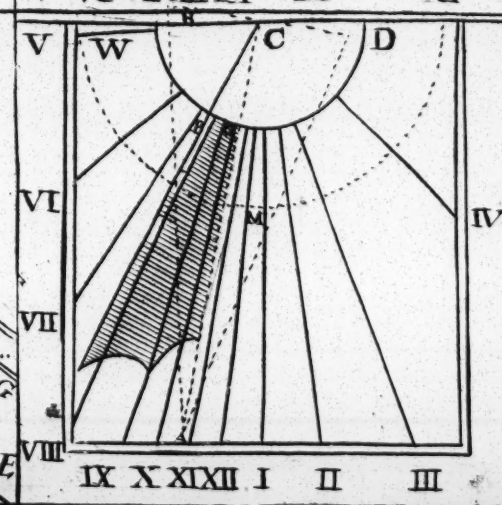
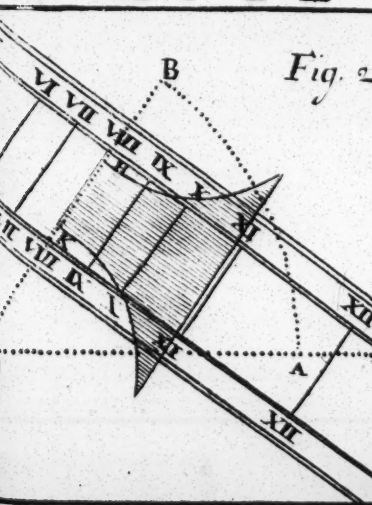
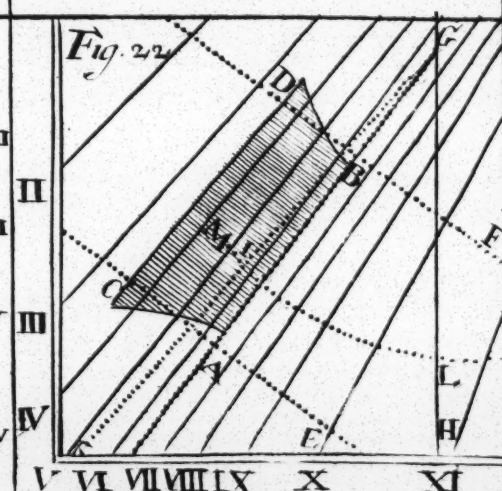
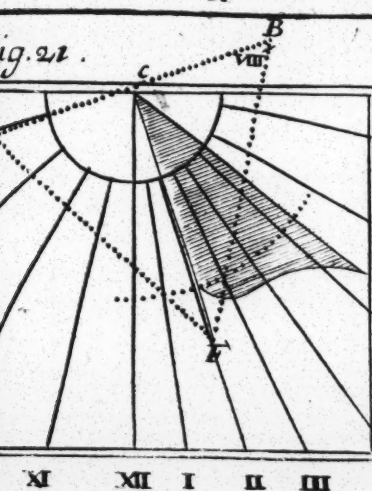
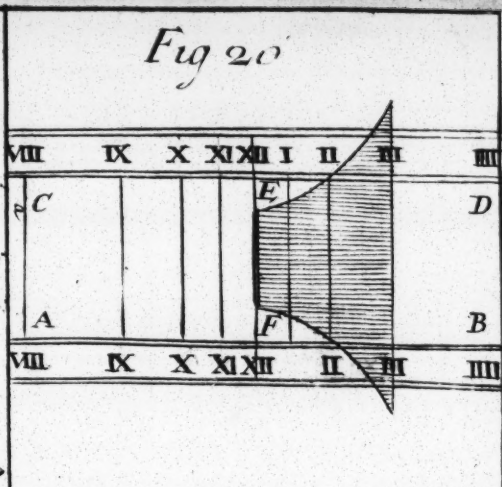
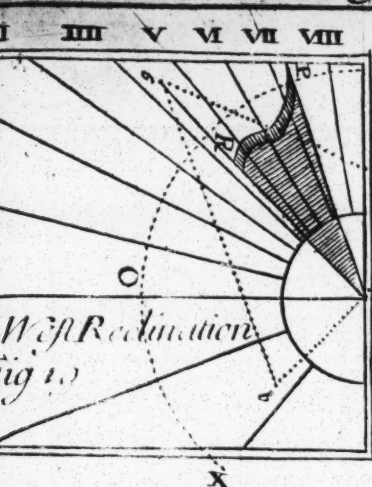
So that when you have made a South-*Dial* reclining from the Zenith 60 deg. (as II the second Variety of *South* recliners in this Chapter) you have also a *North Dial* Inclining to the Horizon 60 deg. either by drawing the Hour-lines and Stil through the Center, or by turning the Reclining *Dial* about upon the Hour-line of VI. And then as the *North Pole* is Elevated upon the *South* recliner ; so much will the *South Pole* be Elevated above the *North* Incliner, &c.

III III

a West R
Fig. 10

Fig. 21

XI



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Of Declining and Reclining PLANES.

CHAP. XI.

As there were six Varieties of Direct North and South reclining Planes, so also are there of South and North Declining reclining Planes, viz. Three Varieties of South recliners declining, and as many of North recliners declining.

Of South Recliners Declining Planes.

I. The Declination may be such, that the reclining Plane, shall intersect the Meridian between the Zenith of the Place, and the Pole of the World.

II. The Declination may be such, that the reclining Plane, may fall upon the Meridian just upon the Pole-point; and such Reclining Declining Planes, are called Equinoctial recliners.

III. The Declination may be such, that the Decliner may fall between the Pole of the World, and the Horizon.

These are the three Varieties of South recliners declining.

In North Decliners reclining, there are three Varieties.

I. The Declination may be such, that the reclining Plane, may cut the Meridian, between the Zenith & the Equator ~~the~~

II. The Declination may be such, that the *North* reclining declining Plane, may cross the *Meridian* in the Point where the Equinoctial cuts it.—And such Planes are called Polar declining Planes, because the Poles of them lie in the Axis of the World, and the Substile in such Plane will be always Perpendicular to the *Meridian* at the Place.

III. The Declination may cause the reclining Plane to cut the *Meridian*, between the Equinoctial and the Horizon.

Examples of all these Varieties follow.

I. Of South Recliners.

The First Variety.

C H A P. XII.

Fig. 2

To draw Hour-lines, upon a South Reclining Plane Declining East or West, which passes between the Zenith and the Pole.

Example.

LET the Lat. of the Place be *North*, 51
 The Decl. of the Plane be *East*, 20
 The reclinacion of the Plane be 20

I. To find the New-Latitude, wherein the Plane stands as an upright Decliner.

The Canon for Calculation,

the Radius	90 00	10,00000
to the Co-sine of the old Decl.	20 00	9,97298
is the Co-Tang. of the Recl.	20 00	10,43893
the Tangent of	68 49	10,41191
the Lat. of the place Subtracted	51 30	
there remains	17 19	
whose Complement 72.41, is the <i>New-Latitude</i> .		
II. The referring of this Plane to a new-La-		
titude, doth alter the <i>Declination</i> also; therefore		
New-Declination must be found.		

The Canon for Calculation,

the Radius	90 00	10,00000
to the Co-sine of the <i>Recl.</i>	20 00	9,97298
is the sine of the old-Decl.	20 00	9,53405
the sine of the new-Decl.	18 45	19,50703

g. 2 Having found the New Latitude and Declina-
 n, you may find the Subfiles distance, the Stiles
 height, and the *Planes* difference of Longitude,
 the Chapter, which are as followeth.

The height of the Pole above the <i>Horiz.</i>	51 30	
the Planes old Declination,	20 00	
the Reclination	20 00	
the Planes New Latitude	72 41	
the Planes New Declination	18 45	
the Subfiles distance from the <i>Meridian</i> ,	05 43	
the Stiles height.	16 23	
the Planes difference of Longitude,	19 34	
	H 2	The

Having found the Longitude and rest of the things necessary, you may frame a Table of Angles at the Pole, as was directed in the Chapter in upright decliners; and from thence you may find also the Hour *Arches*, and set them down in a Table as you see here followeth.

		<i>Angles at the Pole</i>		<i>Hour Arches</i>			
<i>H. East.</i>	<i>d.</i>	<i>m.</i>	<i>d.</i>	<i>m.</i>	<i>H. East.</i>	<i>ft.</i>	
5	85	:	26	74	:	11	7
6	70	:	26	38	:	26	6
7	55	:	26	22	:	16	5
8	40	:	26	13	:	31	4
9	25	:	26	07	:	38	3
10	10	:	26	02	:	58	2
<i>Substile</i>							<i>Substile.</i>
11	04	:	34	01	:	17	1
12	19	:	34	05	:	44	12
1	34	:	34	11	:	00	11
2	49	:	34	19	:	07	10
3	64	:	34	31	:	40	9
4	79	:	34	56	:	53	8

But to draw this *Dial* upon the Plane of the old Latitude, you are not to place the Hour-*Arches* of 12 perpendicular to the *Horizon*, as in upright *Planes*; but it must make an *Angle* with the *Horizontal* line of the rectifying *Plane*: And therefore the quantity that *Angles* must be found therefore,

The Canon for Calculation is,

As the Radius.	90 00.	1000000
As to the sine of the Reclination.	20 00	953405
So is the <i>Tang.</i> of the old Decl.	20 00	956106
To the <i>Co-Tan.</i> of the dif. of the M. & H.	82 54	909511

Having found the Quantity, the *Meridian* makes with the Horizontal-line; the next thing is to find to what Coast it must run, and either above it or below it.

Now in all South Planes that doth recline and decline so much that the Plane becomes less than an *Equinoctial* Plane, the *Meridian* doth descend below the Horizontal line at that end which lies contrary to the Coast of the Declination. And in all North Planes Inclining and Declining, so much as to make it less than an *Equinoctial* Plane, the *Meridian* will ascend above the Horizontal line at that end which lies contrary to the Coast of the Planes Declination. *W. B. at 33° Project. Dial.*

Having shewed you to what Coast the *Meridian* must run; we now come to the drawing of the Dial, Geometrically.

The Geometrically Projection.

Draw the line W C E, for the *Horizontal* line of the Plane, then in the point C, with 60. deg. of Chords describe the Circle W M E, and from W, to M, (because the Plane Declines East) set 82. 54, the distance of the *Meridian* and *Horizon*, and draw the line C M, for the Hour-line of 12.

Then take 05. 43. the *Substiles* distance, and set from M, to O, and 16. 23, and set from O

H 3

to

to P, and draw CO, for the *Substile*, and CP, for the *Stile*.

Lastly, Take 01. 17, 05. 44, 11. 00, 19. 07, 30. 40, and 56. 53, and set from O towards E, Likewise take 02. 58, 07. 38, 13. 31, 22. 16, 38. 26, and 74. 11, and set from O, towards W, and from C, the Center draw lines to every one of the Points, they will be belonging to the Plane.

How to draw this Dial by the Line of Latitudes, and Hour Scale; the Requisites being Calculated.

Having drawn your Horizontal, and set off the distance of the *Meridian* from the *Horizon*, the *Substiles* distance from the Hour line of 12 or *Meridian*, and the *Stiles* height, draw a Line as B D, passing thro, the Center C, and *Perpendicular* to the *Substile*.

Then out of your Scale of *Latitudes*, in page 62 take 16, 23, and set from C to B, and D, then take in your *Compasses*, the length of the whole Scale of 6 *Hours*, and set one foot in B, and turn the other foot till it touch the *Substile*, as at A, and draw a line A B, and A D.

The *Inclination* of *Meridians* in this Example, was found to be 19. 34, seek that on the second Scale of 90 deg. and just against it on the first Scale you shall find 1 hour 19 min. which shews that the *Substile* stands upon 19 min. past 1, on the *Dial* declining *West*, and 41 min. past 10 on the *Dial* declining *East*.

Now repair to your Table of *Angles* at the Pole, and take 04. 34, from your Scale of *Inclination* of *Meridians*,

Mer. and set from A, to XI, and from B, to V, then
 take 19. 34, and set from A, to XII, and from B,
 to VI. then take 34. 34, and set from A to I, and
 from B, to VII. then take 49 34 and set from A,
 to II, and from B, to
 VIII. then take 64. 34.
 and set from A, to III.
 and from B, to IX.
 then take 79. 34, and
 set from A, to IV, and
 from B, to X. *Lastly*,
 Lines drawn from the
 Center C, thro' every
 one of these points shall
 be the *Hour-lines* for
 such a *Dial*.

<i>East.</i>	<i>A.</i>	<i>P.</i>	<i>West.</i>
11	04 34		I
12	19 34		12
I	34 34		11
2	49 34		10
3	64 34		9
4	79 34		8

*How to find what time the Sun forsaketh the North
 Inclining Plane to shine upon this South reclining
 Plane.— The Sun being in Cancer.*

As the Radius	90 00	10,00000
As to the Co-Tan. of the Suns Decl.	66 30	9,68865
So is the Tang. of the Stiles height.	15 45	9,45029
To the Co sine, of	82 57	9,08894
From which Subt. Planes Long.	19 34	
There will remain	63 23	

which converted into time, by allowing 15 deg.
 for every Hour, and a deg. to 4 min. gives 4 *Hours*
 13 min. after Noon, when the Sun parteth from the
 Plane, declining and reclining 20 deg. 00 min. *East-*
wards, and shineth upon the *North Inclining West*,
 H 4 the

the part opposite thereto : To find the time in the Morning, when the *Sun* forsaketh the *North* Inclining *West*, to shine upon the *South* declining *East*.

Unto the Co-sine before found *viz.*
Add the planes Longitude,
The Sum is,

82, 31
19, 31
101 : 9

Which is 202. 31, that be resolved into time giveth 6 hours 50 min. from Noon, that the *Sun* leaveth the *North* Inclining Plane, to shine on the *South* Recliner : Or if you take the Complement of 102. 31, to 180 deg. which is 77. 29, it giveth 5 hours 10 min. the time from Noon.

C H A P. XIII.

HAVING the Declination given, to know what Reclination will make it an *Equinoctial* Dial : Or having the Reclination given, to know what Declination it requires to make it also an *Equinoctial* declining Dial.

Whereby you may know at any time if your reclination and declination : or declination and reclination makes your Dial plane more, or less than an *Equinoctial* declining Dial.

Let the Declination given be 65 deg. 40 min.

As the Radius	90 00	10,00000
As to the Co-Tang. of the Lat.	51 30	9,90060
So is the Co-sine of the Decli.	65 40	9,61494
To the Tang. of the Reclination	18 09	19,51554

Let the Reclination given be as found 18 09.

As the Radius	90 00	10,00000
As to the Tang. of the Latitude	51 30	10,39939
So is the Tang. of the Reclinat.	18 09	9,51563
To the Co-sine of the Declina.	65 40	19,61502

C H A P. XIV.

Fig. 23.

How to draw the Hour-lines upon any Declining Equinoctial Plane.

Let the Example be of a South Plane, Declining East 65 deg. 40 min. and Reclining 18 deg. 9 min. in the Latitude of London 51 deg. 30 min.

IN Declining Reclining Equinoctial Dials, before the Hour-lines can be drawn, Three Things must be given, and two Things found; the Things given are,

1. The Latitude of the Place, 51 30
2. The Declination of the Plane, 65 40
3. The Planes Reclination, 18 9

The

The Things found are,

1. The Distance of the *Meridian* and *Horizon*
2. The Inclination of the *Meridians*.

For the Distance of the *Horizon* and *Meridian*, Thus,

As the Radius, or sine of 90 deg. 10,00000
Is to the sine of the Reclination, 18 9—9,49346
So is the *Tang.* of the Declinat. 65 40 10,34465
To the *Tangent* of 34 deg. 34 min. — 19,83811

Whose Complement 55 deg. 26 min. is the Distance of the *Meridian* and *Substile* from the *Horizontal*-line.

For the Inclination of the *Meridian* of the Place from the *Meridian* of the Plane, Thus,

As the Radius, or sine of 90 deg. 10,00000
Is to the sine of the Latitude 51 30—9,89354
So is the *Tang.* of the Declina. 65 40 10,34465
To the *Tang.* 59 deg. 55 min. ——— 10,23719

Now because 59 deg. 55 min. is almost 4 hours distance from the *Meridian*, I conclude that the *Substile* shall fall near 8 of the Clock, on the West side of the *Meridian*: Because the Plane declines East.

The Requisites being found, Draw the *Horizontal*-line DA, then with the Radius of your Line of Chords, describe the Arch AB, and set thereon

from A to B 55 deg. 26 min. the distance of the Meridian or Substile from the Horizon, and draw D for the Substile. Then perpendicular to the Substile, draw the Lines F G and C E, having and the Inclination of Meridians to be 59 deg. min. find it on the *second Scale*, and against it the first *Scale* you shall find 3 Hours 59 min. Then having Recourse to the Table following, off the Hours from K to H, according to the directions of the 27th Chapter, for the far declination, taking the several Distances with your Com-

From K towards E.		From K towards C.	
M.	H. on the Plane.	H.	M. H. on the Plane.
59	K	90	1 K
59	K	101	1 K
59	K	112	1 K
59	K	123	1 K
59	K	14	1 K

passes out of either of the Polar Scales, and setting them off from K towards C and E, as the Table plainly sheweth, drawing Lines parallel to the Substile through those Points, and those lines shall be the Hour-lines required for that Plane. The extent of the Compasses from the beginning of the same Polar Scale to the Hour of 3, gives the height of the Stile above the Substile, which may be a Plate of Iron or Brass set up just over the Substile H K; and so the Dial is finished.

S E C T. I.

How to find what Time the Sun passeth from one side of an Equinoctial Plane to the other.

EVERY Plane Reclining to the Equinoctial concident, with some Hour-Circle, or parallel, and therefore the Sun, in what parallel passeth from one side of that Plane to the other, at the same Hour and Min. which you may see by the following Canon.

As the sine of the Latitude	51	30	9,893
Is to the Radius	90	00	10,000
So is the Co-Tan. of the Plan. decl.	65	40	9,655
To the Tangent of	30	00	9,761

Which 30:00 being converted into Time, giveth 2 Hours from Midnight, when the Sun passeth from the Inclining to the Reclining Plane, and reckoned from Noon, when the Sun forsaketh the reclining Plane, and shineth upon the Inclining side again. And thus it continues till the Northern Amplitude or the Sun is equal to 65:40 the Declination of the Plane, from thenceforth it shines no more upon the Inclining Part in the Morning, and when the Southern Amplitude or the Sun is equal to 65:49, the Declination of the Plane, then it forsaketh the inclining side at evening also, and the rest of the Year it only enlighteneth the reclining side of the Plane.

Note, The Meridian in all these Planes is North and South.

C H A

C H A P. XV.

Fig. 32.

How to draw Hour-lines upon a South Reclining Dial, declining East or West, which passeth between the Pole and the Horizon.

THE third Variety in *South* declining reclining Dials, is of those that pass between the Pole of the World and the Horizon; therefore because the Plane falleth between the *North* Pole and the Horizon, therefore the *North* Pole is elevated above it; from whence you may conclude that the Center of the Dial must be downwards upon the Plane, and the Hour-lines running upward to the *North* Pole.

Example, Let the Latitude of the Place be 51 30
 The Declination of the Plane be 33 00
 The Reclination of the Plane be 55 00

I. To find the Latitude of the Place wherein this Plane stands as an upright Decliner.

As the Radius	90 00	10,00000
Isto the Co-sine of the old Dec.	30 00	9,93753
So is the Co-Tan. of the Decl.	55 00	9,84522
To the Tangent of	31 14	19,78275

The Difference between this Tangent and the Latitude 51 30, is 20 16, whose Complement 69 44, is the New Latitude.

II. The referring of this Plane to a New Latitude, doth alter the Declination; therefore a new Declination must be found.

As

As the Radius,	90 00	10,0000
Is to the Co-sine of the reclina.	55 00	9,7585
So is the sine of the old Decl.	30 00	9,6989
To the sine of the new Decl.	16 40	19,4575

Having found the new Latitude and new Declination, you may find the *Subfiles* distance from the *Meridian*, the *Stiles* height, and the Plane difference of Longitude, as you were directed for upright Decliners.—Only Note, Instead of using the Old Latitude and Declination, you must use the new Latitude and Declination.

The distance of the Meridian and Horizon may be found by the Directions of the 12th Chapter Page 98.

Old Latitude,	51	30			
Old Declination.	30	00			
Reclination of the Plane.	55	00			
New Latitude.	69	44			
New Declination.	16	40			
Subfiles Distance from	06	03			
Stiles Height.	19	25			
Planes Longitude.	17	42			
Meridians Distance from the Horizon.	64	41			
Hours from Equinoctial the Subfile. Distances.			Hour Ar- ches.	Hours from the Subfile.	
East Dial.	D.	M.	D.	M.	West-Dial.
5	87	22	82	07	7
6	72	22	46	17	6
7	57	22	27	26	5
8	42	22	16	52	4
9	27	22	09	46	3
10	12	22	04	10	2
Subfile.					Subfile.
11	02	38	00	53	1
12	17	38	06	02	12
1	32	38	12	01	11
2	47	38	20	01	10
3	62	38	32	42	9
4	77	38	56	35	8

Having found the Requisites you may frame a Table of Angles at the Pole, according to the Direction of Upright Decliners. From thence you may find the Hour Arches and set them down as you see in this Table.

The Geometrical Projection.

1. Draw the Horizontal-line A B, then on G
 the Center, with 60 deg. of Chords, describe the
 Circle AEB, then take 64:41, the distance of the
Meridian and *Horizon*, and set from B to C, be-
 cause the Plane declines Eastward, and draw the
 line G C, for the *Meridian* or 12 a Clock; then
 take 06:03, the Substiles distance from the *Me-
 ridian* and set from C to D, on the Right-hand of
 the *Meridian*, because the Plane declines East-
 wards, also take 19:25, the Stiles height and set
 from D to E, and draw G E, for the Substile, and
 E, for the Stile.

Then from the same Line of Chords you de-
 scribed your Circle AEB, take 82:07, 46:17, 27.
 6, 16:52, 09:46, 04:10, and set from the *Substile*
 for the Hours of 5, 6, 7, 8, 9, and 10 in the
 forenoon: Then take 00:53, 06:02, 12:01, 20
 3, 32:42, 56:25, and set from D, the Substile,
 for 11, and 12 at Noon, and 1, 2, 3, 4, in the
 afternoon, and from C, the Center of your *Dial*
 draw Lines thro' the several Points, you have the
 four-lines desired.

Lastly, Let the Stile make an Angle of 19:25,
 above the Plane, and be set perpendicular to the
 substiler-line G F, and raise the Plane to make
 an Angle of 35 deg. above the *Horizon*, and de-
 clining *East*, 30 deg. it will shew the true Time
 of the Day: Wherein note, That having made
 is one Dial (or any of the like) you have at once
 made four, changing but the Position of the *Dial*,
 and altering the number of the Hours, as the
 use doth require, For first, this answereth to
 the

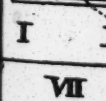
the opposite *North* declining 38 deg. *West*, and Inclining to the *Horizon*, 55 deg. also the *South* declining *West*, 30 deg. and reclining 55 deg. and to his opposite *North* declining *East* 30 deg. and reclining 55 deg.

And note, In all *South* Recliner more than an *Equinoctial* the *Meridian* doth ascend above the *Horizontal-line*, at the end which lies the same way with the *Planes* Declination.

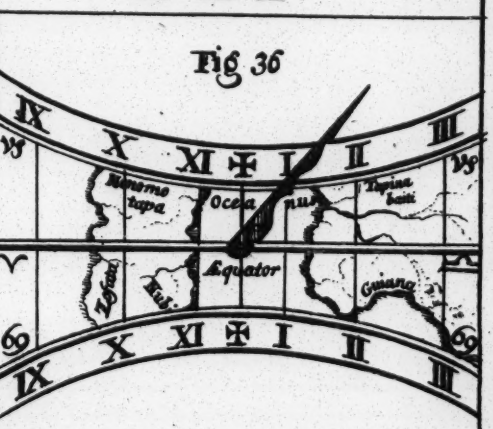
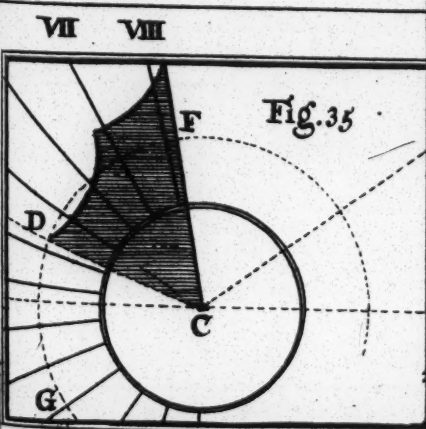
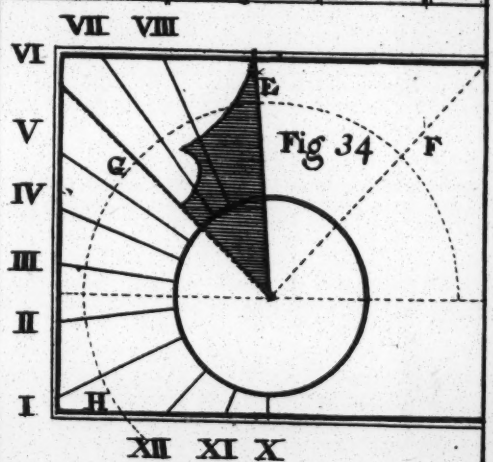
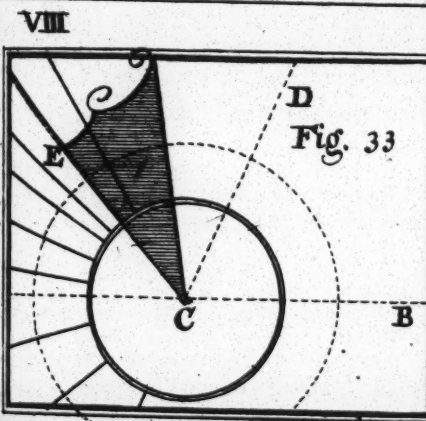
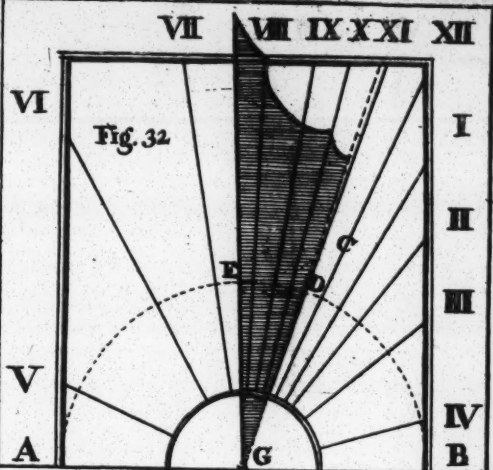
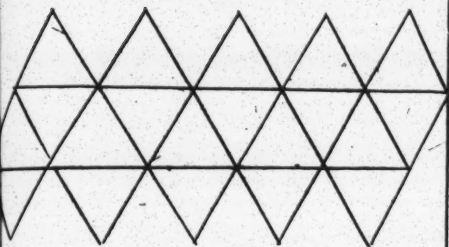
And in all *North* Inclining Declining *Planes* more than the *Equinoctial*, the *Meridian* doth descend below the *Horizontal-line*, at that end which lies the same way with the *Planes* Declination.

Those *South* *Planes* are *Equinoctial* Decliners whose Reclination, and Declination maketh them fall into the *Pole* of the *World*, that is, the *Plane* doth pass thro' both *Polar*, and by that reason the *Stile* doth make no Angle with the *Plane*, but doth lie parallel to it, and those *Planes*, are said to be less than *Equinoctial* *Planes* that pass between the *Zenith* and the *Pole*, and those more than *Equinoctial* *Planes* that pass between the *Pole* and the *Horizon*.

Note, That in the Operation (in *South* *Planes* in finding the New Latitude, if that the *Tangent* that comes out be equal to the Latitude of the Place, that *Plane* is said to be an *Equinoctial-Plane* but if more than the Latitude, it is less than an *Equinoctial-Plane*, but if less than the Latitude then is it more than an *Equinoctial-Plane*.



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S E C T. I.

the Latitude of the place, the Sun's Declinations with the Declination, and reclinacion given, to find what time the Sun forsaketh the South reclining Plane, to shine upon the North reclining opposite thereto.

AS the Radius 90 00 10,00000
 Is to the *Tan.* of the *S. decl.* 23 30 9,63830
 As is the *Tan.* of the *Stiles* heig. 19 25 9,54713
 So the *Co-sine* of 81 11 19,18543
 Unto this *Co-sine* 81 11. add the *Planes* Longitude 17 42, the whole Angle is 98 53—90
 g. is 6 hours, therefore 08. 53. resolved into
 me giveth no Hours, but 35 min. before 6 at
 eight, when the Sun in *Cancer* forsaketh the
Plane reclining, to Shine upon the Inclining side
 thereof, or again the *Co-sine* 81. 11. resolved in-
 time giveth 5 Hours 25 min. from Noon, that
 the Sun in the Morning, parteth with the North
 reclining *Plane*, to Shine on the South reclining
Plane, opposite thereto. Thus I have done with
 South reclining *Dials*.

Of North Recliners.

C H A P. XVI.

Fig. ^{3. 3.} ~~24~~

How to draw Hour-lines, upon a North Reclining Declining Dial 60 deg. Westward. and Reclining 6 deg. from the Zenith toward the Equinoctial.

1. To find the New Latitude.

I

AS

As the *Tan.* of the Planes reclamation 16,3
C. Arithmetical — 0,5425
 Is to the *Radius* — 90 00 10,0000
 So is the Co-sine of the Planes decl. 60.00.9,6989
 To the Co-Tangent of — 29 50 19,2414

This *Co-Tang.* being compared with the Latitude
 51. 30, there difference 21. 40, is the new *Latitude*

2. To find the New *Declination*.

As the *Radius* — 90 00 10,0000
 Is to the Sine of the Declination, 60 00 9,9375
 So is the Co-sine of the Reclina. 16 00 9,9828
 To the sine of the New declina. 56 ~~46~~ 19,9202

3. To find the distance of the *Mer.* and *Horizon*

As the *Radius* — — 90 00 10,0000
 Is to the Sine of the *Reclinat.* 16 00 9,4402
 So is the Tangent of the old decl. 60 00 10,238
 To the *Co-Tan.* of the dist. }
 of the Meridian and Horizon, } 64 29 19,678

The *Latitude* of the Place — 51
 The *Reclination* of the Plane 16
 The decl. of the Plane from the *NorthWest*. 66
 The New *Latitude* — — 21
 The New *Declination* in that *Latitude*, 56
 The distance of the *Mer.* and *Horizon*, 64
 The distance of the Substile from the *Mer.* 64
 The *Stiles* height above the Plane, 30
 The Planes difference of *Longitude* 76

Having found these things, as you were directed
 forme

formerly, you may proceed to the making of a
Table of *Equinoctial Distances*, and so calculate
the true Hour Distances, as you were Taught in
Bright Decliners, and they will be as followeth.

The Geometrical Projection,

Draw an Hori-
zontal-line almost
the Middle of
the Plane, as *AC*,
then chuse a
Point in the Hori-
zontal-line for a Cen-
tre, as at *C*, and
draw 60 deg. of
Arcs make the
Circle *ABG*, from
the East Point of
the Horizontal-line, *G*
by help of a line
Chords, set *A, G*
64, 29, the di-
stance of the Me-
ridian, and Horizon,
the North part
of the Meridian, or
properly from

West De- cliner.	Equino- ctial Di- stances.	True Hours distance.	East De- cliner.
Hours.	D. M.	D. M.	Hours.
1	88 50	87 44	11
2	73 50	60 37	10
3	58 50	40 24	9
4	43 50	26 18	8
5	28 50	15 49	7
6	13 50	7 13	6
Substile.			Substile.
7	1 10	0 36	5
8	16 10	8 29	4
9	31 10	17 18	3
10	46 10	28 12	2
11	61 10	43 5	1
12	76 10	64 26	12

the West point of the Horizontal-line upwards
to the South part thereof, and draw the Line
12, for the 12 a Clock Hour-line; from *D*
64, 29, the distance between the Sub-
stile and the Meridian Eastwards from it, and
draw the pricked line *CE* for the Substile, from

the point *E*, in the Substile, by help of a Line of Chord, set off the True Hour distances both ways in the Circle towards *G*, and *D*, as you find them in your Table; unto every prick draw straight Lines from *C*, ~~to~~ the Centre, so shall you have all the hour-lines proper for this Dial.

Lastly, from *E*, to *F*, set off the height of the stile 30:59, and draw the Line *C, F*, representing the *Axis*, which being erected at right Angles over the Substile *C, E*, and must point upwards toward the North Pole, so is the *Dial* fit for Use and must be placed according to the Declination and Reclination of the *Dial*.

Note, In Declining Reclining less than a Polar, the Meridian ascends above the Horizontal Line the same way with the Coast of Declination, and represents 12 a Clock at Night; and in the Declining Inclining Dial less than a Polar, the Meridian doth ascend below the Horizontal Line the same way with the Declination.

A. D. 1699 *Projective Dial. Proves this Note.* S E C T. I.

How by having the Lat. of the Place, the Declination, the Declination and Reclination given, to find what Line the Sun parteth from South Incliner, to Shine upon the North Recliner, opposite thereto.

As the Radius	90	10,00	
Is to the Tan. of the Sun's decl.	23 30	9,63	
So is the Tan. of the Stiles heig.	30 59	9,77	
To the Co-Sine of	74 52	19,41	

Out of the *Planes* Long. 76: 10, take 74: 52,
 here will remain 1 deg. 18 min. which conver-
 ted into Time, giveth only 5 min. before Noon,
 when the *Sun* forsaketh the Inclining side of the
Plane.

C H A P. XVII.

Fig. 34.

How to draw Hour Lines upon a Polar Dial, De-
 clining East or West 60 deg. and Reclining
 32:11.

BEfore I shall shew how *Hour Lines* are to be
 described on these *Dials*, I shall shew, how
 having a *Declination* given, to find a *Reclination*
 that will make it a *Polar Declining Dial*: Or ha-
 ving the *Reclination* given, to find what *Declina-*
tion will do the like.

The Canon for Calculation.

As the Co-Tan. of the Lat. Com. Arith.	51 30	0,09939
Is to the Radius —	90 00	10,00000
So is the Co. Sine of the <i>Planes</i> De.	60 00	9,69897
To the Tan. of the <i>Reclination</i> .	32 09	9,79836
Again,		
As the Radius —	90 00	10,00000
Is to the Tan. of the <i>Reclination</i> .	32 09	9,79830
So is the Co-Tan. of the Latitude	51 30	9,90060
So is the Co sine of the <i>De. requ.</i>	60 00	9,69890

In these sort of *Planes* you have only the height
 of the *Stile* above the *Substile*, and the distance
 I 3 of

of the *Meridian* to find ; now forasmuch as the distance of the *Subfile* from the *Meridian* is 90 00, and by that reason the *Plane* is an upright *Plane* where there is no *Latitude*, therefore the distance of the *Equator*, from the *Pole* being 90 00, also ; therefore the *New Declination* will be equal to the height of the *Stile*, which you may find by the following *Canons*.

As to the <i>Radius</i> .	90 00	0,00000
Is to the <i>Sine</i> of the <i>Planes Decl.</i>	60 00	9,93753
So is the <i>Co-sine</i> of the <i>Reclin.</i>	32 09	9,92770
To the <i>Co-sine</i> of the <i>Planes new De.</i>	42 52	19,86520

Which is the Height of the *Stile* above the *Subfile* ; also you may find the distance of the *Meridian* and *Horizon* by this *Canon*.

As the <i>Co-Ta.</i> of the <i>Planes De. C. A.</i>	60 00	0,23856
Is to the <i>Radius</i>	90 00	10,00000
So is the <i>Sine</i> of the <i>Planes Recli.</i>	32 09	9,72602
To the <i>Co-Tangent</i> of	47 20	9,96458

The <i>Latitude</i> of the <i>Place</i>	51 30
The <i>Declination</i> of the <i>Plane</i>	60 00
The <i>Reclination</i> of the <i>Plane</i>	32 09
The <i>New Latitude</i>	00 00
The <i>New Declination</i> in that <i>Lat.</i>	42 52
The <i>Distance</i> of the <i>Subfile</i> from the <i>Mer.</i>	90 00
The <i>Height</i> of the <i>Stile</i> above the <i>Plane</i>	42 52
The <i>Planes Difference</i> of the <i>Longitude</i>	90 00
The <i>Dist.</i> of the <i>Meridian</i> and <i>Horizon</i>	47 20

Hence you may see the *Planes Difference* of
Longitude,

the *Longitude*, being 90 deg. the *Substile* must be the
 90 a Clock Hour-line, and the Hour Angles on
 either side of the Hour of Six is equal, therefore
 it is but the adding of 15 deg. on either side the
 90 *Substile*, and you have a Table of *Equinoctial* Di-
 stances, and from thence you may calculate the
 may True Hour, as you were taught in *Upright De-*
cliners. The Table followeth.

The Geometrical Projection.

The Table

being prepa-

red, draw the

Horizontal-

Line A, C, B,

near the mid-

dle of the

Plane and Pa-

rallel to the

Bottom, in a-

ny Part there-

of, at the

Center C, with

60 deg. of Chords draw the Circle H, G, E, F,

and set 47:20, the distance of the *Meridian* and

Horizon, from B, the *West* End of the *Horizontal*

Line to F, upwards, and draw the Line F, C, D,

for the Hour of 12, then set 90 deg. the *Sub-*

files distance from the *Meridian*, from F, to G,

and draw C, G, for the *Substile* and Hour-line

of 6, set off from G, each way, by help of a

Line of Chords upon the Circle E, G, H, the

Hour distance, as you find them in the Table,

Hours from the Subst.	Equino- ctial di- stance.	True Hours distance.	Hours from the Substile.
Hours	D. M.	D. M.	Hours
6	Substile	Substile	6
5	15	10 20	7
4	30	21 27	8
3	45	34 14	9
2	60	49 41	10
1	75	68 30	11
12	90	90 00	12

I 4 viz.

viz. for the *Hour* of 5, and 7, 10 deg. 20 min. for 4, and 8, 21 deg. 27 min. and so of the rest (but past 8 you need add no more,) so shall you have *Points* unto which streight lines being drawn from the *Center*, are the true *Hour-lines* on the *Plane*.

Lastly, From *G*, either way set off the height of the *Stile* 42 deg. 52 min. from *G*, to *E*, and draw the line *C, E*, for the *Axis* of the *World*, which being erected perpendicular over the *Substile*, the *Dial* is finished; but observe that your *Dial* be set to its true *Declination* and *Reclination* proper to the same.

Note, The *Meridian* in all North Declining *Polar Dials*, descend below the *Horizontal-line* at that End which is contrary to the *Coast* of the *Declination*: And the *Meridian* in all South Declining *Polar Dials*, doth descend also from the contrary *Coast* of *Declination*, and the six *Clock hour-line* is always the *Substile* in both.

N.B. in 38th Page of the Dial. note this. S E C T. I.

The *Latitude* of the *Place*, the *Declination* of the *Sun*, together with the *Reclination* and *Declination* given to find what *Time* the *Sun* forsakes the *South Inclining side*, to shine upon the *North Declining side*, opposite thereto.

As the <i>Radius</i> ,	90 00	10,00000
Is to the <i>Tan.</i> of the <i>Sun's Decl.</i>	23 30	9,63839
So is the <i>Tan.</i> of the <i>Stiles</i> heig.	42 52	9,96762
To this <i>Co-sine</i> ,	66 12	9,60592

Out of the *Planes* Longitude 90 deg. take
 66.12, there will remain 23.48, which converted
 into time, giveth one hour 35 min. before Noon,
 when the *Sun* leaveth shining on the Inclining,
 and shineth upon the Reclining side.

C H A P. XVIII.

Fig. 35.

*How to draw the Hour-Lines upon a North Dial
 declining 60 deg. West, and reclining 54 deg.
 which cutteth the Meridian between the Equino-
 ctial and the Horizon.*

THE making of this *Dial* differeth little from
 the former, therefore find the Requisites
 as you did in the former, that is first the New
 Latitude and New Declination find the distance of
 the Meridian and Horizon, and the Subfiles di-
 stance from the Meridian, the Stiles height above
 the Plane, the Planes Longitude; and Hours di-
 stances as you have been taught in the former
 Chapters.

I shall not trouble you with Calculating the
 Requisites from this Plane; because they may be
 found by the last Chapter but one, and therefore
 it is needless to say any more about them, but
 they are Calculated, and are as followeth.

The Latitude of the Place		51 50
The Declination of the Planes <i>West</i>	—	60 00
The Reclination of the Plane	— —	54 00
The Plane's new Latitude	— — —	18 30
The Plane's new Declination	— —	30 36
		The

The distance of Meridian and Horizon 35 3
 The Sub. distance from the Mer. 123. 09. or 56 4
 The Stiles height 54 4
 The Plane's Longitude 118 13, or 61 4

Having the Plane's difference of Longitude
 you may frame a *Table* of Equinoctial distances
 and find the Hour distances, and place them as in
 this *Table* following.

The Geometrical Projection.

Hours.	Equino- ctial di- stance.		True Hour distance.		Hours.
	D.	M.	D.	M.	
12	61	48	56	41	12
11	46	48	40	49	1
10	31	48	26	50	2
9	16	48	13	50	3
8	1	48	1	97	4
Subfile.					Subfile.
7	13	12	10	51	5
6	28	12	23	39	6
5	43	12	37	29	7
4	58	12	52	48	8
3	73	12	69	43	9

Draw the *Horizon*
 zontal Line *D*,
A, about the mid-
 dle of the Plane
 Parallel to the bo-
 tom, then at *C*,
 a *Centre* with
 deg. of Chords de-
 scribe the Circle
F, *D*, *G*, and from
 the *East* point
 the *Horizon* from
B, to *G*, set 35. 3
 the Distance of the
Meridian and *Ho-*
rizon, and draw

the Line *C*, *G*, for
 the *Twelve a Clock* hour-Line, then set off
 41. the Subfiles distance from the Meridian from
G, to *D*, and draw the Line *C*, *D*, for the Sub-
 file, and set off 54.46 from *D*, to *F*, for the Stiles
 so shall *D*, *F*, be the Stiles height above the Plane

the *Twelve a Clock* hour-Line, then set off
 41. the Subfiles distance from the Meridian from
G, to *D*, and draw the Line *C*, *D*, for the Sub-
 file, and set off 54.46 from *D*, to *F*, for the Stiles
 so shall *D*, *F*, be the Stiles height above the Plane

then set the *Hour* distances from the *Substile* both ways, as you find them in the *Table* (as you have been taught in the foregoing Chapters) and thro' the Points draw Lines, and set the *Stile* right over the *Substile*, and then you have finished four several *Dials*. This for one, and his Opposite inclining 54 deg. to the *Horizon*, and Declining East 60 deg. and his opposite *South* Inclining 54 deg. and Declining 60 deg. *West*, only turning the *Dials* upside down, and changing the Figures of the *Hours* for Forenoon and Afternoon, as the *Dials* will direct you; and so may be done to all *Dials* whatsoever, except the direct *East*, or *West*, for there can be but two, for the back-side of the *East*, is the *West*.

Note, The *Meridian* in all *North* Recliners more than at *Polar* (as this is one) doth ascend above the *Horizontal-line*, and from that End which lies contrary to the Coast of the Plane's declination, and in the *South* Inclining and Declining more than a *Polar*, the *Meridian* doth descend above the *Horizontal-line*, contrary to the Coast of the Declination, and is only serviceable to draw the *Dial*.

Note also, In the *North* Reclining Declining *Dials*, if that *Tangent* that comes out in finding the new *Latitude* be equal to the Complement of the *Latitude* of the Place, then is that a *Polar Plane*, if the Complement of the *Latitude* exceed the *Tangent*, then is the Plane less than a *Polar*, if the *Tangent* found, doth exceed the Complement of the *Latitude*, then is the Plane more than a *Polar-Dial*.

S E C T. I.

Having the Latitude of the Place, the Sun's Declination, with the Declination, and Reclination of the Plane, given to find what Time the Sun forsaketh the South Inclining side to shine on the North Reclining side Opposite.

As the Radius,	90 00	10,0000
Is to the <i>Tan.</i> of the <i>Sun's Decl.</i>	23 30	9,6383
So is the <i>Tan.</i> of the <i>Stiles</i> heig.	54 43	10,1502
To this Co-sine of	52 05	19,7885

Unto the Angle 52:25, add the *Plane's Longitude* 61:47, from the *North*, or out of the Angle 118:13, counted from the *South*, there remains 66:08, which converted into Time, gives 4 Hours, 14 Min. before Noon, when the Sun forsaketh the Inclining side of the Plane, and shineth upon the Reclining side thereof.

C H A P. XXI. Fig. 12, & 13.

Directions for making Two Sorts of SPOT DIALS, very useful to shew the Hour within the House.

A Description of the Spot-Dial.

THE *Spot Dial*, is of two sorts; in the one the bright Spot goes to the Lines, in the other the Lines go to a black Spot; the former being explained

explained, the latter cannot be unknown. The manner of drawing the Hour-lines, is the same was shewed on any other Dials, in the foregoing Chapters ; but consider, if there was an Axis or Stile on this Dial, it would pass through the Back-board (which all such Dials must have) and the very Point where the Axis doth go through, is the Place where a hole in the one, and a spot in the other is to be made, that at any time (the Sun shining) will shew you the Hour of the Day.

S E C T. I.

For the making of these Dials.


1. Get the Joyner to make you a moulded wooden Frame, with miter-joynts, like the frame of a Looking-Glass, or such a Gilt Frame, as are made for Pictures ; about 8 Inches long, 5 Inches broad, and an Inch and half thick, and nail upon one of the longest edges of the Frame a piece of thin Board a little longer than the Frame, and but half as broad : This piece of Board is for the bottom, and be sure that your Frame stands exactly perpendicular upon the bottom piece : Then for the back of your Frame, get a thin plate of Wood, exactly fit for it, and at the top of this Plate of Wood make a hole about 3 Inches long, and two Inches broad, and upon that nail a piece of Tin, or rather Copper-Plate.

2. You must get a piece of Crown Glass fit for your Frame, and grinde one side of it till it is as lucid as Paper, thus : Lay your Glass upon a Linnen,

nen, or Woolen Cloth to keep it from breaking, then with a small piece of Glafs, and *Calice-Sand* grinde your Glafs, but you must have a great care not to grinde the other side; for in little time you may so smutch the Glafs by heedless mistake on the side, as to make it useles.

3. Having found the Declination of your Glafs-Window, against which it is to stand, make a Dial exactly the bigness of your Glafs upon Paper, to that Declination, with *Stile* and *Substile* drawn upon the Paper, as if you were to make it for the Wall without Doors, or outside of the Window: but the Figures of this *Paper-Dial* must be inverted, or made backward as in Figure 13; and if you Write in *Roman Letters*, for Nine you must Write Eleven; and therefore your best way is to have a Copy before you, of Figures so drawn.

4. Now to find where the Spot will be; remember that it will be always in the *Substile*, and as far distant from the *Stile*, as is the distance between your Glafs and the Tin: Put therefore your Glafs already ground, into the Frame, and take the nearest distance between your Glafs and Tin; for this end make a square of Paper; and applying one side to the Glafs as it lies in the Frame, make a point at the nearest distance, and clip off the rest of the Paper at that point; with that distance come to your Dial on the Paper, and lay the longest edge of this square to the *Substile*, and carry it backward or forward upon the *Substile*, till the marked point just toucheth the *Stile*; then holding it, draw a line from the *Substile* to the *Stile*, and mark that point upon the *Paper-Dial*, where this Line cutteth the *Substile*, viz. at the corner of the

the Square (which I call the *Substile point*) and draw a round  about it, that you may know again.

5. Having drawn your *Paper-Dial* the exact likeness of your Glass, and found your *Substile-point*, you must draw the Hour-lines upon the rough side of the Glass, thus: Wet the Figured side of your *Paper-Dial* with Gum-Water, and lay it on the smooth side of your Glass; and when it is dry, set one Foot of your Compasses upon the Center of the *Dial*, and open the other to the *Substile-point*; with that distance describe a *Semicircle*, and from that *Semicircle* draw all your Hour-line with a Pen and Ink, by the side of a Ruler upon the rough side of the Glass; your figures must be drawn wrong as they appear through the Glass, which you will find to be right when your Dial is in the Frame, and finish'd.

6. Mark your *Substile-point* upon your Glass, and take off your *Paper-Dial*.

7. Make fast your Glass in the Frame with small Tacks, the rough side next the *Back board*.

8. Make a little hole in the Tin, perpendicular over against the *Substile-point*, which you will find by the *Paper-square*; by which you may draw a perpendicular line from the *Substile-point*, and sink it upon the Top of the Frame, and so draw down your *Back-board*; then take the distance from the *Substile-point* to the outermost Edge, or Top of the Frame, and set it upon your line drawn on your *Back-board*, from the Top downwards, which distance will be perpendicular over your *Substile point*.

9. And lastly, With *White-lead* and *Linseed-Oyl*

Oyl ground together, Paint the rough side of the *Glass*; then glue on your *Back-board*, and your *Dial* is finished.

Now your *Dial* being made, set it close to your *Glass-Window*, and the *Sun* entring thro' the little hole, will cast its *Ray* upon the opposite *Hour-lines*, and so give the time of the *Day*.

I need not say much of that *Form*, wherein the *Lines* go to the *Spot*, for it is but the same inverted, as if you should turn this upside down, and draw the *Lines* towards *Window* or *Street*, upon a clear *Transparent Glass*, and on the inside toward the *House*, instead of the *Plate of Wood*, and the *Tin*, you must have a *Glass* ground, with one black *Spot* at the bottom, where the hole is in the *Tin*, unto which *Spot* every *Line* will come successively, according to the time of the *Day*; and the *Figures* must be made upon the clear *Glass* at the *Top*; and there must be a great square *Quarry* of *Glass* in the *Window* behind it, for the *Leads* will make a very unhandsome *Confusion*.

S E C T. II.

How to draw Hour-lines upon the Window-board, Walls, and Floor of a Room, the Sun shining through a small Hole made in any Pane or Quarry of Glass in the Window.

First, if in the *Glass-Window* of any *Room*, one *Pane* or *Quarry* of *Glass* be darkned, and a *Hole* made about half a quarter of an *Inch* diameter in the middle thereof, the *Sun* shining upon the *Window*

Window, will through that hole cast a bright *Spot of Light* into the *Room*, which as the *Sun* in his motion passeth by the *Window*, the *Spot of Light* will be also removed from place to place, sometimes upon the *Window board*, sometimes upon the *Jambs*, sometimes upon the *Sides* and sometimes upon the *Floor* of the *Room*: If such a *Hole* should be supposed to be the *Nodus* or *Point* of the *Top* of the perpendicular *Stile* of any *Dial*, I may from it the *Hour-lines* of a *Sun-Dial*, or of several *Dials* (for every side or part of the *Room* a different *Plane*) may be made about the *Room*

1. *Horizontally* you apply an *Horizontal-Dial* to the *Hole* in the *Glass-Window*, and extend a Thread *Horizontally* also from that *Hole*, over every *Hour-line* (or half and quarter *Hour-line*) till it touch the *Sides*, *Doors*, *Windows*, *Jambs*, or other *Objects* or *Impediments* (standing in the way) about the *Room*: Then,

2. The *Twelve* a *Clock Hour-line*, being both a *Hour-line*, and an *Azimuth* also; you may (by perpendicular *Thread*, or *Threads*,) transfer the *Time* to the *Cieling* or *Floor* of your *Room*, or to which of them will best serve your *Turn*, and sometimes there may be occasion for both: Then,

3. In this *Meridian line* find any *Point*, from which a *Line* or *Thread* extended to the *Hole* in the *Window*, may represent either the *Direct* (or *Reverted*) *Axis* of the *World*, and unto that *Point* all the *Hour-lines* which you draw in that *Room* will have respect unto, (or be in the same *Plane* with) this *Axis*: and therefore,

4. If you fix a *Thread* in one or both of these
K Points,

Points, (or *Poles* rather) and extend that *String* by the side of another *String*, extended from the *Hole* over any *Hour-line* or *Point*, found on the side of the *Room* (as before) that moveable *String* being gently moved by the side of the *Horizontal String*, shall trace out (upon all *Objects* that meets withal) the *Hour-line*, which the extended *Horizontal String* doth represent.

CONCAVE DIALLING

CHAPTER XXII.

How to draw Hour-lines in the Inside of Regular Concaue Hemispheres.

THese *Regular Concaue Hemispheres* are the most natural *Planes*, upon which *Hour-lines* may be described, for they do naturally represent the *Sphere*; and the manner how the *Hour-lines* and *Furniture* may be described, into such *Dials*, shall be the Work of this and the next Chapter.

S E C T. I

Fig. 1

To make a Horizontal Concaue Dial.

HAVING a *Concaue Hemisphere* prepared: S. N. E. W. divide the *Limb* into 4 *Quadrants*, noted as the former *Letters*; one of the *Quadrants* divided into 90 deg. open your *Compass*

affes to the Quadrant, and setting one Foot upon
 . or W. with the other, draw the *Meridian* or
 2 a Clock *Hour-line* SZN take out of the Qua-
 rant, the *Latitude* 51 deg. 30 min. and set those
 degrees upon the *Meridian* from S, towards Z to
 which P, shall be the *Pole* of the World; then
 placing your Compasses upon P, (they being
 opened to a Quadrant) draw the *Equinoctial Circle*
 EW, which divide into 12 equal Parts; your
 compasses being opened as before to a Quadrant,
 and one Foot being placed in those Marks, made
 on the *Equinoctial*, with the other Foot describe
 circles, which shall be the *Hour-lines* required;
 the *Stile* must be erected in P, with an Angle of
 30 deg. 30 min. the *Latitude* of the Place; and
 equal to the length of 60 deg. of the Quadrant,
 the Top must hang over the Center of the *Hemi-*
sphere Z, and be parallel with the Limb, or erect
 the *Stile* in the Point Z, of the same length with
 the former, which shall shew the hour with the
 Top only.

S E C T. II.

how to make a Direct South or North Concave
 Dial.

THIS Dial is made altogether like the former,
 only instead of setting off the *Latitude* from
 P, you must only set off the Complement
 of the *Latitude* 38 deg. 30 min. and the *Hour-*
lines only from 6 to 6, are described thereon; the

rest of the Hour-lines, are reserved for a *Direct Dial* beholding the *North*.

S E C T. III.

Fig. 15

How to make a Direct East or West Concave Dial

LET the Hemisphere be ZSNG, the Limit being divided into four Quadrants, and one of them into 90 deg. from N, upwards, and from S, downwards, set the Latitude to P, then open your Compasses to a Quadrant, one foot being set in P, with the other draw the Circle QEA, which Circle divide into 12 equal Parts, your Compasses being opened to a Quadrant, one foot placed in each of these marks, with the other draw Circles which shall be the *Hour-lines* required, as in *Figure 15*, The *Stile* may be a *Wire* laid from P to P, or a *Wire* erected in the Center E, equal to the Semidiameter of the Quadrant; for better Instruction see the Figure, which is an *East Dial*.

In the same manner is an *Equinoctial Dial* made only all the hours from 6 in the Morning till 6 at *Night*, must be drawn, as the rest above those proper for the *East* or *West* Dials are, and as the pricked hours 9 17 and 6, in the Figure.

Also the Hour-line of 6, viz. the Line P 6 P must be P 12 P, and the rest number'd as in the Figure is expressed, and number'd with *Arithmetical Figures*.

S E C T. IV.

Fig. 16.

How to make a South or North Declining Concave Dial.

YOUR *Concave* being prepared, quartered and marked with the Letters ZNEW, your Compasses being opened to a Quadrant, and one foot in Z or N, draw the *Horizontal Circle* ESW, take the *Declination*, and prick it down in the *Horizontal Circle* from W to H, one foot of your Compasses remaining in H, and being opened to a Quadrant, describe the *Meridian*, or hour of 12, in which from Z, set off the Complement of the *Latitude*, or from it's intersection with the *Horizontal Circle*, set off the *Latitude* to P, one foot of your Compasses being in P, and being opened to a Quadrant, draw the *Equinoctial* QÆA and where it is intersected by the hour of 12, begin to divide it into 12 equal Parts, one foot of your Compasses being placed in each of these points, and being opened to a Quadrant, draw lines which shall be the *Hour-Lines* required. For the *Stile*, that must be erected in P, and the top of it must pass through the Center, of the *Limb* of the *Concave*, and be equal to the length of 60 deg. of the Quadrant, or you may erect the *Stile*, in the point S, the length equal to the former; which will shew the hour of the day with the very top of it.

Note, This Figure Declines *West*; which if it
K 3 had

had declined *East*, the Declination must have been set from E.

S E C T. V.

How to make a Polar Concave-Dial.

A *Polar Concave-Dial*, is nothing but an *Horizontal-Dial*, in the *Latitude* of 90 deg. and of all others is most easie to be made, for if you divide the Limb of the Concave *Hemispheres* into 24 equal Parts, and from the Center of the Concave, (by help of a thin Ruler that will bend) draw streight Lines to each of them, those shall be the Hour-lines required.

For the *Stile*, it must be a streight Wire erected Perpendicular in the Center of the Concave, whose shadow will at all Times (the Sun shining) give the hour of the Day, and the hours of these *Dials* must be numbred from 12 to 12.

Of The FURNITURE in CONCAVE DIALS.

C H A P. XXIII.

S E C T. I. *How to draw the Parallels of the Sun's Declination, in the foregoing Concave Dials.*

THE *Equator* being drawn, set off the degrees of Declination from the *Equator* in the *Meridian*

have *Meridian* of the Concave or *Substiler*, both upwards and downwards; then place one foot of your Compasses in the Pole, and extend the other to those you marked from the *Equator*, draw Circles, which shall be the Parallels of the *Sun's* Declination required; As for *Example*, the drawing of the two *Tropicks*, which declines 23 deg. 30 min. from the *Equator*; take 23 deg. 30 min. and prick it down in the *Meridian* both ways, then place one foot of your Compasses in the Pole, and with the other extended to 23 deg. 30 min. describe the two *Tropicks*; as in *Figure 14.* appears.

S E C T. II.

How to draw the Azimuths or Vertical Circles.

Divide the *Horizon* into 180 deg. beginning where it's intersected by the *Meridian*; if you would draw every 10th *Azimuth*, then you may only divide it into 18 equal Parts, beginning at the same Place; but if you would only draw every 15 *Azimuth*, then divide the *Horizon* into 12 equal Parts, beginning as before at the *Meridian*, if you would draw the Points of the Compass, divide the *Horizon* into 16 Parts, then open your Compasses to a Quadrant, place one Foot in any of those *Divisions*, and where the other Foot intersects the *Horizontal Line*, shall be the Center for drawing that *Azimuth*.

S E C T. III.

How to draw Planetary or Unequal Hours.

FOR the drawing of the *Planetary Hours*, having first described the *Horizon*, *Equator*, and the two *Tropicks*, divide that part of the *Tropick* which is intercepted betwixt its intersection with the *Horizontal-Circle*, into 12 equal parts beginning at 12; the *Equator* being before divided into 12 equal parts by the *Hour-lines*, open your *Compasses* to a *Quadrant*, one foot being placed in one of those *Divisions*, move the other foot until you find the *Center*, which will draw both those *Points* into one *Circle*; and draw *Circles* which shall be the unequal *Hours* required.

S E C T. IV.

How to draw Hours from Sun Rise, to Sun Set, called the Italian and Babylonish Hours.

PLace one foot of your *Compasses* in the *Pole*, and extend the other to the *Intersection* of the *Horizon* and *Meridian*, and describe the *Parallel* of the *Latitude*, which shall be divided into 24 equal parts by the *Hour-circles*, place one foot of your *Compasses* in each of those *Divisions* (the *Compasses* being opened to a *Quadrant*) the other foot, being placed within the *Circle* of *Latitude*, and in the *Hour-circle*, which passeth through the

Points where the Compasses is set in the Circle ; making that the Center, describe Circles from one Tropick to another, which shall be the Hour-lines from *Sun rise* to *Sun set* ; and shall pass by the Intersection of the Hour-lines and the *Equator*.

S E C T. V.

How to draw the Almicanter.

HAVING found the Points of *Zenith* and *Nadir*, the distance of these Points to the *Horizontal line* into 90 deg. one Foot being placed on one of these Points, the other extend to those Degrees, Circles drawn from one Tropick to another, shall give *Almicanter*s or Circles of *Altitude*.

CONVEX DIALLING.

C H A P. XXIV.

How to make a Dial, upon the Convex Superficies of a Globe which shall shew the Hour, by the Shadow, which separateth the Enlightened Hemisphere from the Opacus.

THE Performance of this is very easy, for (the Globe being truly *Spherical*) if the *Equinoctial Circle*, the two Tropicks, and the two *Polar Circles* which will be necessary for ornaments only to be described thereon, and your *Equinoctial Circle*

Circle (or middle of your *Globe* which is all one) be divided into 24 equal Parts, and marked with 1, 2, 3, &c. to 12, and then beginning again with 1, 2, 3, &c. to 12. Then if you *Elevate* one of the Poles so many degrees above an *Horizontal-line*, as the Pole of the *World*, is *Elevated* above your *Horizon*, and place one of the *Hour-points*, that is marked with 6, to behold the *Midian* of the Place, then will the two 12 of the *Clock Hour-points* behold one the *East* and the other the *West* part of the *Horizon*; and then the *Sun*, at all Times shining upon the *Globe*, will enlighten one Hemisphere, and the other will be shadowed, and where the *Line of Shadow* falleth amongst the *Hour-points* upon the *Equinoctial*, will shew the *Hour of the Day*, in two Places *viz.* one on the *East*, and another on the *West* side of the *Globe*.

Note, If you open your *Compasses* to a Quarter of the distance, round the *Equinoctial Circle* of your *Globe*, and place one Foot in the Marks made in the *Equinoctial*, with the other you may describe the *Hour-lines*, from one *Tropic* pick to the other, or if you will from one *Pole* to the other.

A TABLE containing the Latitude, of most
of the Eminent Cities and Towns in Eng-
land, Scotland and Ireland.

Places in England and Wales.	D. M.	Places in Scotland and Ireland.	D. M.
LONDON	51 30	Rochester	51 29
York	54 00	Peterborough	52 33
Oxford	51 54	Chichester	53 50
Cambridge	52 17	Hertford	51 51
Norwich	52 44	Newark	53 2
Canterbury	51 27	Stafford	52 55
Bristol	51 30	Shrewsbury	52 48
Colchester	52 4	Lancaster	54 8
Glocester	52 0	Winchester	51 10
Hereford	52 14	Leicester	52 40
Monmouth	51 51	Pembroke	51 46
Tarmouth	52 45	Worcester.	52 20
Warwick	52 25	In Scotland.	
Flint	53 17	EDENBURG	55 56
Salisbury	57 0	Glasgow	55 52
Northampton	52 18	St. John's	57 44
Newcastle	54 58	St. Andrew's	57 45
Lincoln	53 15	Sterling	57 18
Nottingham	53 3	Berwick	55 49
Boston	53 2	Aberdene.	58 40
Chester	53 20	In Ireland.	
Wakefield	53 54	DUBLIN	53 11
Coventry	52 30	King'sale	51 40
Darby	53 6	Cork	51 47
Bedford	52 18	Wexford	52 18
Huntingdon	52 99	Waterford	52 22
Cardiff	52 2	Limerick	52 30
Hull	53 50	Tredagh	53 38
Ipswich	52 08	King's-Town	53 8
St. David's	52 0	Queen's-Town	52 52

REFLEX DIALLING.

C H A P. XXV.

Reflection is to be made by a piece of *Looking-Glass*, which is so much the better, by how much it is thinner; for the Thickness of it causeth a double Ray of Light to be reflected and requires a greater Elevation of the *Sun's Beams* than a thin one doth: It must be about seven Times the Thickness in breadth; and because *Glass* reflects from upper and nearer *Superficies*, and so makes two *Spots*, colour the lower *Superficies* thereof with *Oyl Colour*, and it will make but one *Spot*.

How to make a Dial upon the Cieling of a Room, that is parallel to a piece of Glass, placed exactly Horizontal.

FIRST, determine the most convenient Point in the Window where to place the *Reflecting Glass*, as near the *Cieling* as you can conveniently, provided it be not so near as that the Cornish of the Window will shadow the *Glass* when the *Sun* is high in Summer, suppose within 10 or a 11 Inches of the *Cieling*; then find a Point upon the *Cieling* directly over your *Glass*, thus: Hold a Line and Plummer to the *Cieling* just over it, and the Place where the Plumline toucheth the *Cieling* is the Point; then through

his Point draw a *Perpendicular* to your *Window*: Now if your *Window* be exactly *South*, this *Perpendicular* upon the *Cieling* will be a *Meridian-line*; but if your *Window* declines the true *Meridian-line* will make an Angle with this *Perpendicular*, equal to the quantity of its Declination. Therefore having found the Declination of your *Window*, take 60 deg. of Chords, and setting one Foot in the Point on the *Cieling*, with the other describe a Circle, and let thereon (from the *Perpendicular*) the Declination of your *Window*, toward your Right-hand if *West*, but toward your Left-hand if *East*; then draw a Line from the point on which you describe your Circle, which Line shall be your *Meridian-line*.

2. Draw an *Horizontal-Dial* upon the back of some Table, or some Plaister-wall, or Floor.

3. Take the distance between the *Glass* and the *Cieling* with your *Compasses*; then come to your *Dial* on the *Wall*, and lay one side of your Square to the *Meridian-line*, and the other crossing the *Stile*; then move the Square upon the *Meridian-line*, till the Extent of the *Compasses* does exactly touch both *Stile* and *Meridian-line*, and that point of the *Stile* which does touch the Square, may be called the *Glass-point*, from which erect a *Perpendicular*, and where it cuts the *Meridian-line* make a Point, which will be the *Equinoctial Point*, from which also erect a *Perpendicular*, which will be a *Tangent*; then at some distance on which side of the *Equinoctial Point* you find most convenient,

ent, erect another *Tangent*, these two *Tangent* will cut the *Hour-lines* in the *Points*, which may be called the *Hour-Points*.

4. Take the Distance between the *Glass-Point* and *Equinoctial-Point*, and extend it from the *Glass* to the *Meridian-line* on the *Cieling*, and where it toucheth, that is the *Equinoctial-Point* upon the *Cieling*.

5. Set off correspondent *Tangent-lines* upon the *Cieling*, and making like *Hour-Points*, through those *Points* draw the *Hour-lines*.

6. This *Dial* is nothing but an *Horizontal Dial* inverted, the *Center* being in the *Air*, except you make a *North Dial*, (which is seldom done) then it will be upon the *Cieling*, which you may find by its distance from the *Equinoctial Point*; then upon that *Center* describe a *Circle*, and likewise out of that *Center* erect a *Perpendicular* to the *Meridian-line*, for the *Hour-line* of 6; and you have no more to do but to set off from the *Hour-line* of 12, all the other *Hours* according to their *Spaces*, in an *Horizontal Dial*.

Lastly, Let your *Dial* on the *Wall*, remain to take *Distances* for uses at any other *Time*.

CYLINDRICAL DIALLING,

EITHER

Concave or Convex.

C H A P. XXVI.

Of those that fall in a Right Sphere, viz. such as lie Parallel to the Axis of the World, and their Bases Parallel to the Equinoctial.

HOUR-lines may be drawn upon those Cylinders, with great Ease and Exactness, although in them there may be various Positions of the *Axis*.

Sect. I. If the *Axis* fall in the very Center of the Base of the Cylinder, then divide the Circumference of the Base of the Cylinder, in 24 equal Parts, and draw Lines from the Center to each of those Points, which will be the Hour-lines for the Base of the Cylinder: And where those Lines cut the Circumference Lines, drawn from them down the Cylinder's side, they shall be the true Hour-lines, which will be Parallel each to one another.

Sect. II. If the Point of the *Axis*, fall not just in the Center of the Base, of the Cylinder, thro' that Point where the *Axis* falls, and the Center of the Cylinder draw a Line, and with a Pair of Compasses take the nearest distance from
the

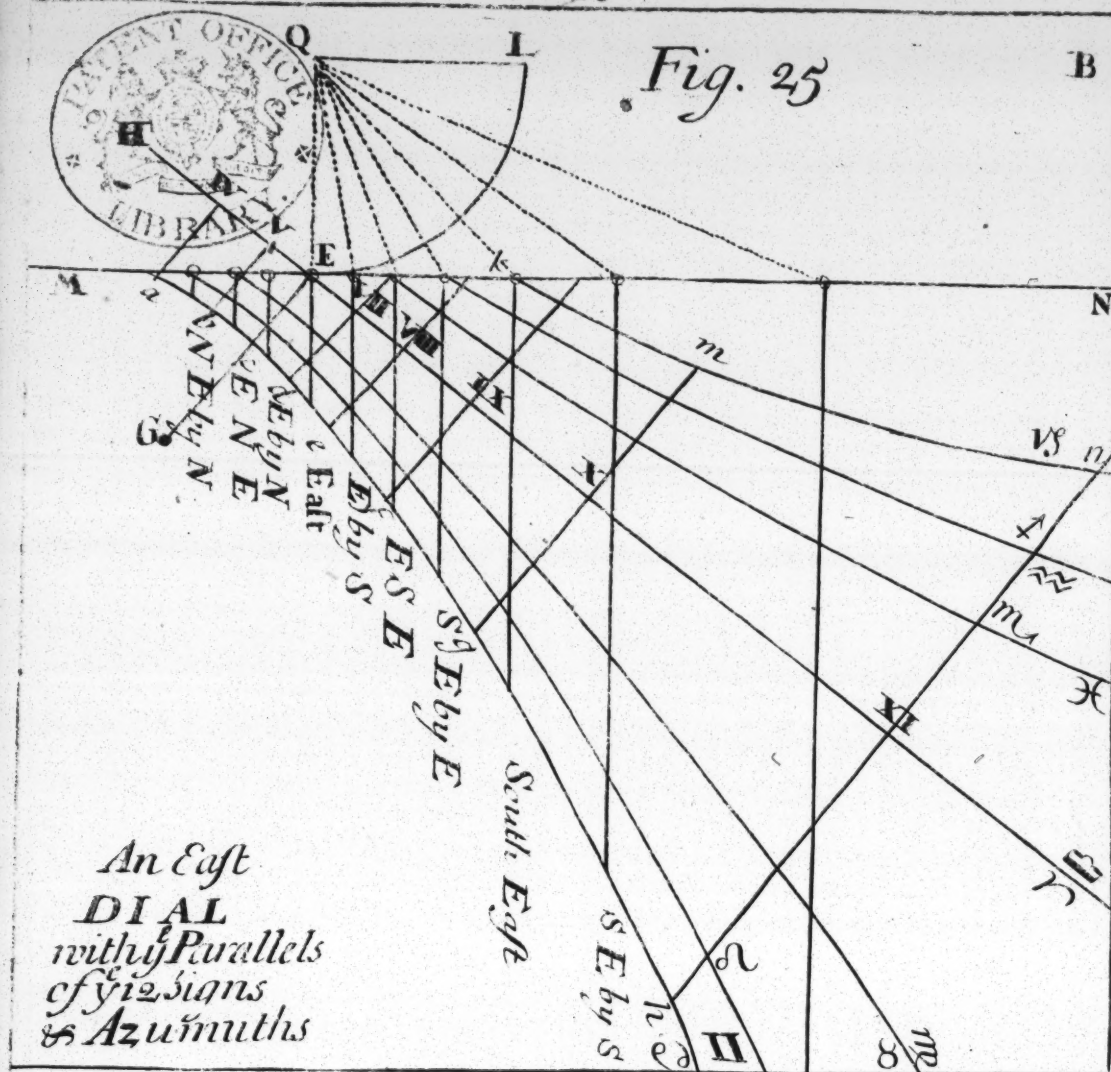
the *Axis point* and describe a Circle, which divide into 24 equal Parts, (beginning at the Diameter first drawn) Lines drawn from the *Axis-Point* through every one of them, and extend to the Side, or Circumference of the Base of the Cylinder, shall be *Hour-lines*, again Lines drawn from them down the side of the Cylinder shall be *Hour-lines* also.

Sect. III. If the Point of the *Axis* fall in any Part of the *Periferie* of the Cylinder's Base. Then divide the *Circumference* of the Cylinder's Base, into 12 equal Parts, beginning at the *Axis Point*; Lines drawn from thence to the several Points, in the *Periferie* of the Circle, and all down the Cylinder's side, they shall be the *Hour Lines*.

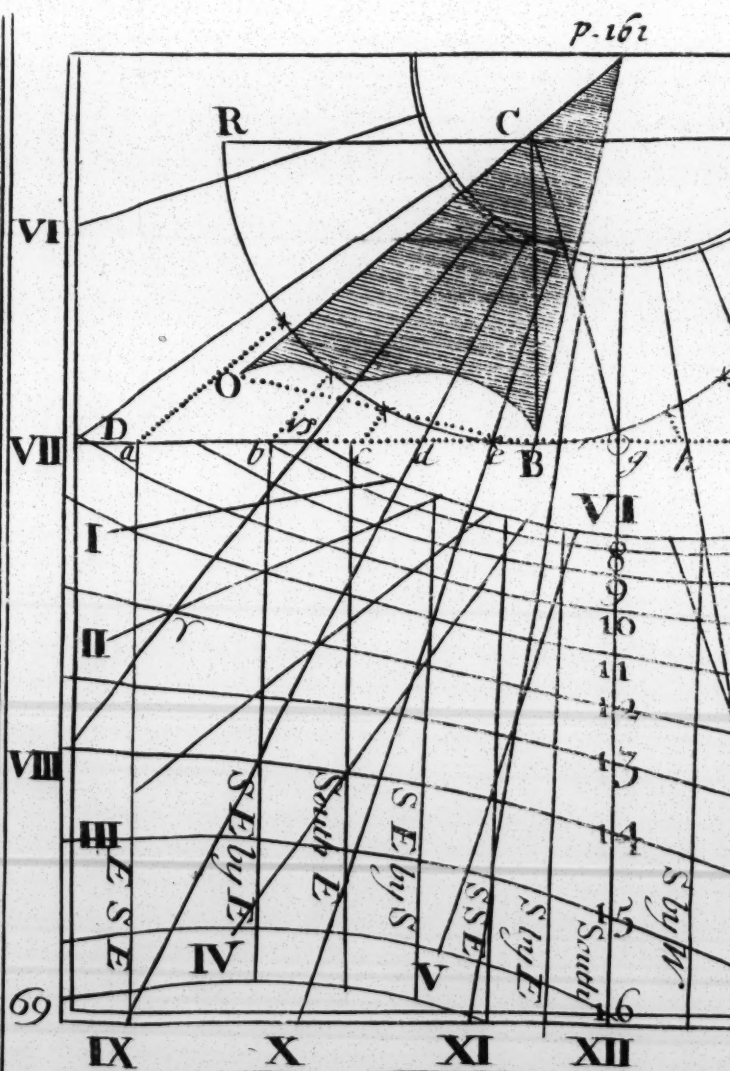
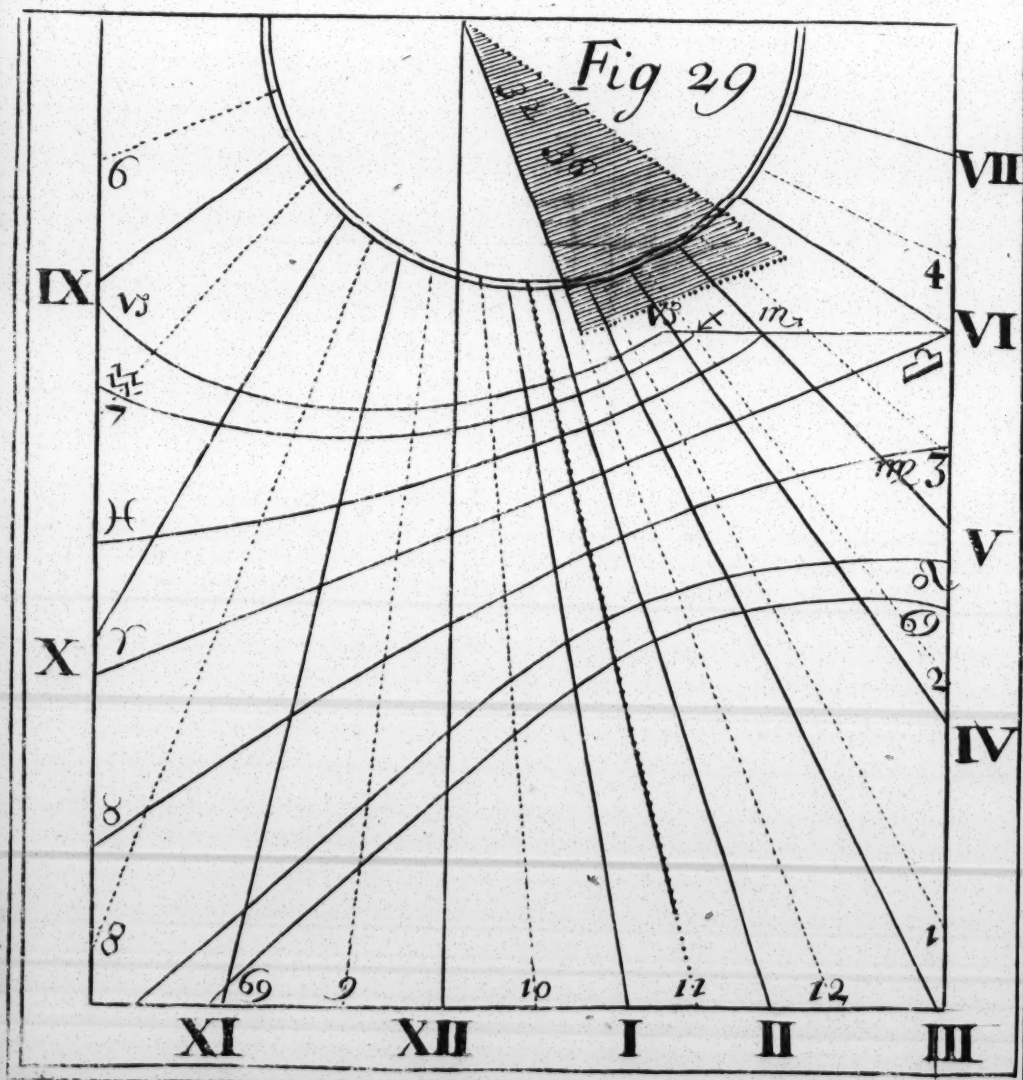
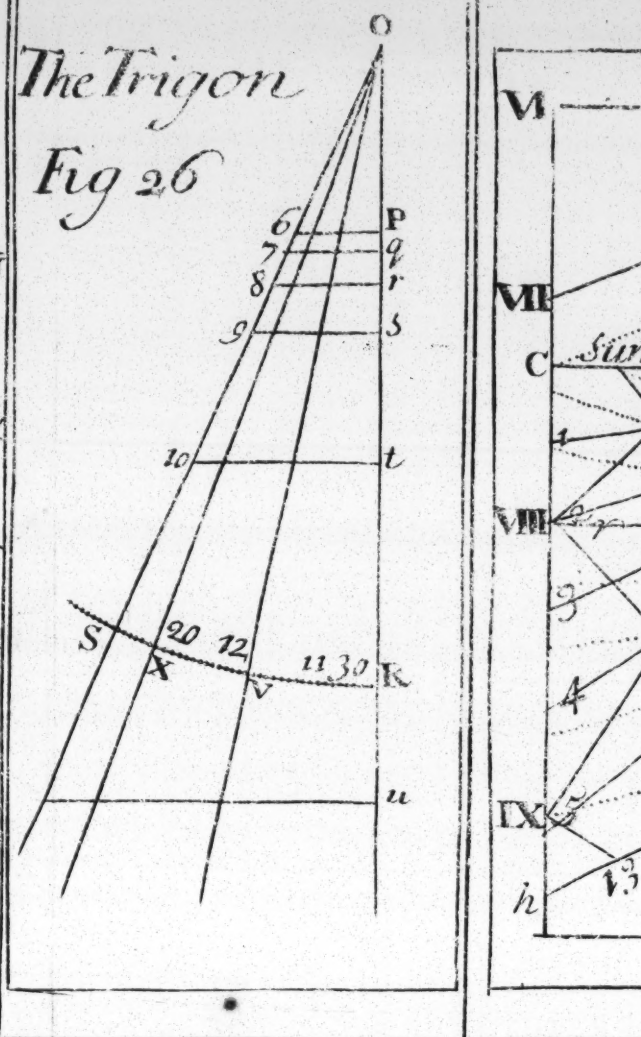
Sect. IV. If the *Axis Point* fall without the Base of the Cylinder. Then the distance between that Point, and the nearest Part of the *Periferie* of the Cylinder's Base, being made Radius, and a Circle be thereon described, and divided into 12 equal Parts; then Lines drawn from the *Axis Point*, through those Divisions shall each of them cut the *Periferie* of the Cylinder's Base, in two Points, from which Lines drawn from one to another (each to this correspondent) they shall be the *Hour-lines*, and from them Point-lines down the Cylinder's side, must parallel Lines be drawn. Also,



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The Trigon
Fig 26



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Of the Furniture with which

Sun - Dials

May be BEAUTIFIED;



How to describe such Furniture upon all Sorts of Upright, Direct and Declining Dials, Geometrically.

C. H. A. P. XXVII.

Of such Circles of the Sphere, as are described upon Sun-Dials.

MAny Astronomical Conclusions, may be performed by describing of the *Circles* of the Sphere upon *Sun-Dials*: Of which I have made choice of these following.

1. The *Parallels* of the Signs, shewing in what part of the *Zodiack* the *Sun* is, at all times of the Year.

2. The *Diurnal Arches*, shewing the length of the Day throughout the Year.

3. The *Hours* from the *Sun's* Rising or Setting, or otherways called the *Babylonish* and *Italian* Hours.

4. The *Jewish* Unequal, or *Plenetary* Hours.

L

5. The

5. The *Azimuths*, shewing in what quarter of the World, or upon what Point of the *Compass* the *Sun's* on at all times of the Day.

C H A P. XXVIII.

How to describe the Equinoctial, the two Tropicks, and other Parallels of Declination, upon any Sun-Dial.

THE two *Tropicks*, being the Boundaries of the *Sun's* Course (for he never exceeds those Limits,) therefore it is best, *first* to shew how they may be described for between them all other *Circles* (either Great or Small) must be Projected, and the manner of describing them upon several Planes various.

S E C T. I.

On the direct East, or West, and Equinoctial Dials.

LET an *Example* be of direct *East* Dials in the *Latitude* of 51 deg. 30 min.

How to describe the Hour-Lines upon these Planes, is shewed in the 4th and 7th Chapters of this Book. Therefore such a *Dial* being drawn as in *Figure 25*, through the Foot of the *Perpendicular Stile*, as at E, draw a Line MEN, Parallel to the *Horizon*; for the *Horizontal Line* in all Planes, must be drawn through the Foot of the *Perpendicular Stile*, and also through the Point

Point where the Equinoctial Circle croſſeth the Hour-Line of Six. Your Dial, with the Equinoctial Line hereof, HES, being drawn, we come to deſcribe the *Tropicks*.

1. Upon a piece of fine Card-paſt-board, draw the Line OR, as in *Figure 26*, representing the Equinoctial Line in your Dial; and (becauſe the *Tropicks* are 23 deg. 30 min. diſtant from the Equinoctial) with 60 deg. of your Line of Chords, upon the Point O, deſcribe an Arch of a Circle, and ſet upon it 23 deg. 30 min. from R to S, and draw the Line OS, representing the two *Tropicks*; and the Angle SOR, you may call a *Trigon*.

2. Out of your Dial take the length of the Perpendicular Stile EG, and ſet it upon your *Trigon* from O to P, and draw the Line P 6 Perpendicular to OR. Alſo,

Take the di-	7	with the Equi-	q	and	q	7	per-
ſtance from G,	8	noctial, and	r	draw	r	8	pen-
to the Interſe-	9	ſet it upon the	s	the	s	9	dicu-
ction of the	10	Trigon, from	t	Lines	t	10	lar to
Hour Line of	11	O, to	v		v	11	OR

Thus having prepared the *Trigon*, out of it take the diſtance P 6, and ſet it upon the 6 a Clock Hour line, from E to c: Alſo take the diſtance q 7, and ſet it upon your Dial from V to , and from VII to d: Alſo take r 8, and ſet it upon your Dial from IV to a, and from VIII to ; Likewise take the diſtances s 9, and ſet it on your Dial from IX to f: Alſo, take s 10, and

set it on your Dial from X to g; Lastly, take v 11, and set it on your Dial from XI to b.

These Points a, b, c, d, e, f, g, h, are the Points through which the Tropick of Cancer must be described; therefore if through them a Line be drawn with an even hand making no Angles, that shall be Tropick of Cancer.

The Tropick of Capricorn may be described in the same manner, for if from your Trigon you take

The distance	{	r	8	{	And set	VIII	k
		s	9			IX	l
		t	10			X	m
		v	11			XI	n
					it upon		
					your Dial		
					from		

Those shall be the Points through which the Tropick of Capricorn must be described; therefore if through k, l, m, n, a Line be drawn with an even Hand, it shall be the Tropick of Capricorn: And,

When the Sun is in	{	Capricorn,	}	which	{	Decem. 11	}	the Shadow	
		Aries,				March, 10			of the top of
		Libra, or				Sept. 12			the Stile will
		Cancer,				June. 11			pass along
								those respec-	
								tive Lines.	

And according to this Method, may any other intermediate Parallels of Declination be inserted as for Example: Suppose I would insert the Parallels of the Sun's entrance into the 12 Signs Aries and Libra are inserted already, also Cancer and Capricorn; for the rest, as when the Sun enters into

<i>Taurus,</i>	{	the <i>Sun</i> hath 11 deg. 30 min.	} of Declinations.
<i>Virgo,</i>			
<i>Scorpio,</i>			
<i>Pisces,</i>			
<i>Gemini,</i>	{	the <i>Sun</i> hath 20 deg. 12 min.	
<i>Leo,</i>			
<i>Sagittarius</i>			
<i>Aquarius</i>			

Therefore take 11 deg. 30 min. and 20 deg. 12 min. out of your Line of Chords, and set them upon the Arch RS of your *Trigon*, from R to V and X, and draw the two Lines OV and OX.

These Parallels, being thus put in your *Trigon*, they may be transferr'd into the Dial, in all Respects as the *Tropicks* were; and as you see done in Fig. 26.

S E C T. II.

In a direct South or North-Dial. Fig. 27.

HAVING drawn your Dial, as is taught in Chapters 2, 3, or together with the Stile, your first work must be to proportion your Stile to your Dial; which to do, assume any convenient Point in the Substile (here the Line of XII) for the farthestmost *Tropick*, as here the Point ☿; then the Stile's height being 38 deg. 30 min. add 23 deg. 30 min. thereto, the Sum is 62 deg. and that is the *Meridian Altitude* of the Sun when he enters *Cancer*, and

L 3

the

the Complement thereof to 90 deg. is 28 deg. Therefore, upon the Point *Cancer*, make an Angle $B \odot A$, to contain 28 deg. so shall the Line $\odot A$ cut the *Axis* of the Stile OA , in A ; then from A let fall a *Perpendicular* to $O \odot$, as AB ; and so is your Stile proportioned to your Dial; and the Line CBD (being drawn Parallel to the *Horizon*, through the Point B) shall be the *Horizontal-Line* of your Dial.

This done, prepare a *Trigon*, as *Figure 28*, in which make EF equal to OA , and FG equal to OB , and EG , to AB , the *Triangle* EGF , in the *Trigon*, equal to the *Triangle* of the Stile OAB , in the Dial.

From the Point E , draw a *Perpendicular* to EF , as $E12$, for the *Equinoctial*; and upon E , with 90 deg. of Chors describe the Arch $H12L$, and upon it set 23 deg. 30 min, from 12 to H and L , and draw the line EH for the *Tropick* of *Cancer*, and EL for the *Tropick* of *Capricorn*: Draw the *Substiler Line* FG , quite through the *Trigon*, crossing the *Equinoctial* in a , and both the *Tropicks*.

This done, out of your *Trigon* take the distance from F to a , and set on your Dial from the Center O to c , through which Point draw the Line Vc for the *Equinoctial*: Then from O , the Center of your Dial, take the distance to the Intersection of the *Hour-Line* of 11. or 1 with the *Equinoctial*, and set it on the *Trigon*, from F to b : Also take the distance from O , to the Intersection of the *Hour-line* of 10 or 2, and set it from F to c : Likewise take the distance from O , to the Intersection of the *Hour line* of 9 or

3, and set it from F to *d*: Lastly, the distance from O, to the Intersection of 8 or 4, with the *Equinoctial*, set from F to *e*; and draw the Lines, *Fa, Fb, Fc, Fd, Fe*, through the *Trigon*, making them 12, 11, 10, 9, 8, and 1, 2, 3, 4, &c. Now to find the Points upon the Dial, through which the *Tropicks* must pass:

The Dist-
ance from
F to

$\left\{ \begin{array}{l} 12 \\ 11 \\ 20 \\ 9 \\ 8 \end{array} \right\}$	will reach from O, the Center of the Dial to	$\left\{ \begin{array}{l} 50 \\ f \\ g \\ b \end{array} \right\}$	on the <i>Hour</i> <i>Lines</i> of	$\left\{ \begin{array}{l} 12 \\ 11 \\ 10 \\ 9 \end{array} \right\}$	$\left\{ \begin{array}{l} 1 \\ 2 \\ 3 \end{array} \right\}$
--	--	---	---	---	---

Through which Points the *Tropick* of *Cancer* must be drawn with an even Hand: And,

The Dist-
ance from
F to

$\left\{ \begin{array}{l} 12 \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \right\}$	will reach from O, the Center of the Dial to	$\left\{ \begin{array}{l} vs \\ k \\ l \\ m \\ vs \end{array} \right\}$	upon the <i>Hour</i> <i>Line</i> of	$\left\{ \begin{array}{l} 12 \\ 11 \\ 10 \\ 9 \\ 8 \end{array} \right\}$	$\left\{ \begin{array}{l} 12 \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \right\}$
--	--	---	---	--	--

Through which Points the *Tropick* of *Capricorn* must be drawn. And thus you have the *Equinoctial*, and the two *Tropicks*, described upon a *Direct South Dial*.

S E C T. III.

How to describe the Equinoctial, and the two Tropicks, on any Upright Dial Declining, or in such as both Recline and Decline.

AN Example of an Upright Dial declining from the *South Westward* 30 deg. The making of these *Dials* is Taught in the fifth and eighth or twenty-sixth Chapters of this Book. Therefore having drawn such a Dial, and the Stile and Substile in a due Position, you will find the Height of the Stile to be 23 deg. 37 min. First, make an Horizontal Dial for the Latitude of 32 deg. 37 min. as in the Declining Dial, Fig. 27, where the Substiler-line is taken for the Hour-line of 12, as it is there marked, and the other Pricked-lines, are the Hour-lines of an Horizontal Dial for the Latitude of 32 deg. 37 min. Now, if according to the Directions of the foregoing Sections you make *Trigon*, and insert the *Equinoctial*, and *Tropicks*, and afterwards expunge the obscure Lines of the *Horizontal-Dial*, the *Equinoctial Tropicks*, and the *Horizontal-line* will be the same, as if they had been inserted from the true *Hour-lines* belonging to the *Dial-Plane*.

And as the *Tropicks* were described, so likewise may the Parallel of the Sun's Entrance into the other Signs, be inserted if into your *Trigon*, you put there *Arches* of Declinations from the *Equinoctial*, Namely, 11 deg. 30 min. and

20 deg. 12 min. And so are the Parallels of the Signs put into the Dial, *Fig. 29.*

And in any Dial, also may the Diurnal Arches be described, if you put into the *Trigon* such Declinations, as the Sun hath from the Equinoctial, when the Days is either,

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Fig. 27, and the *Trigon* thereunto belonging is *Fig. 28.*

C H A P. XXIX.

How the Hours from the Sun's Rising and Setting, are to be described into all Sorts of Sun-Dials.

THE Hours from *Sun-rising*, are called the *Babylonish Hours*, for they begin their Day at the *Sun's Rising*: And the Hours from *Sun-Setting*, are called the *Italian Hours*, for in *Italy* they account their Time from the Setting of the *Sun* the Day preceding.

The manner how to describe the *Hours* (is the same in all Planes, and) is easily performed. And because that upon a full *South*, or *Horizontal Dial*, they will appear most Uniform; I have therefore made choice of a direct *South Dial*, as in Figure 27. to describe them; Your *Dial* being drawn, and the *Equinoctial* $\gamma \infty$, the two *Tropicks* $\odot \odot$, and $\vee \vee$, and the *Horizontal-line*, *Sun-Rise* — *Sun-Set*; you must (by the last Chapter) describe two obscure *Parallels* of *Declination*, one when the Day is 8 Hours long, as $\odot 8 \odot$, and the other when the Day is Sixteen Hours long, as $\ast 16 \ast$, the *Equinoctial* being the *Parallel* when the Day is Twelve Hours long.

Being thus far prepared the *Inscription* of these *Hours* will be very easy; for it is plain, that when the Day is but 8 Hours long, that the *Sun* Rises at Eight in the Morning; and the first *Line* after the *Sun's* Rising is Nine in the Morning; also when the Day is 12 Hours long, the *Sun* Rises at 6 in the Morning, and the first Hour after, is 7 in the Morning; Lastly, when the Day is 16 Hours long, the *Sun* Rises at Four in the Morning, and the next Hour after is Five in the Morning: And all the rest as in this Table. Therefore, a straight *Line* drawn through the Intersection of these *Hours Lines*, with the *Parallels* of 8, 12 and 16 Hours, shall be the First Hour after the *Sun's* Rising all the Year long.

In like manner, if you would insert the seventh after the Sun's rising: By the Table you see, that the Parallel of viii Hours, for the length of the Day, the seventh hour from Sun-rising is 3 in the Afternoon, therefore observe where the Hour-line of 3 crosseth the Parallel of viii Hours, which is at *a*. Also by the Table you see that in the Parallel of xii Hours, for the length of the Day, the

Length of Days.				
		viii	xii	xvii
Hours from Sun-rising.	i	29	7	5
	ii	10	8	6
	iii	11	9	7
	iv	12	10	8
	v	1	11	9
	vi	2	12	10
	vii	3	1	11
	viii	4	2	12
	ix	5	3	1
	x	6	4	2
	xi	7	5	3

seventh Hour from Sun-rising is 1 in the Afternoon; therefore observe where the *Hour-line* of 1 crosseth the *Equinoctial*, which is at *b*. Thirdly, by the Table you see, that in the Parallel of xii Hours, for the length of the Day, the seventh hour from the *Sun's Rising* is 11 in the Forenoon; and therefore observe where the *Hour-line* of 11 crosseth the Parallel of xvi Hours for the length of the Day, which at *c*; so shall a right-line drawn through these Points, *a, b, c*, be the seventh Hour after the *Sun's Rising* throughout the Year: And thus by the help of this Table, you may draw all the Hour-lines from the *Sun's Rising*, as you see them drawn, and numbred as Fig. 27.

In the same manner, as the Hours from the *Sun's Rising* (which are the *Babylonish Hours*) were drawn, may the Hours from the *Sun's Setting* (which

(which are the *Italian Hours*) be drawn: The difference being only in the numbring of them: the hours from *Sun Rising*, being numbred from the *West* end of the *Horizontal-line*, by 1, 2, 3, 4, 5, 6, 7, 8, 9, 10: And the *Hours* from *Sun Setting*, from the *East* end of the *Horizontal-line* backwards, by 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13; as appears in *Figure 27*.

A Corollary arising from the Work of this Chapter

The Hour-lines from *Sun Rising* and *Setting* being described upon any *Dial*, as is before taught, there will by their correspondent Intersections or Intersections with another, be Points produced, through which if Lines be drawn, with an even hand, the same shall be the Parallels, of the length of the *Dial*, and such are pricked Lines in *Fig. 27*, numbred upon the *Meridian-line* of the *Dial*, by 8, 9, 10, 11, 12, 13, 14, 15, 16.

C H A P. XXX.

Of the Jewish, or Old Unequal, or Planitary hours, and how they may be described upon any Sun Dial.

THE Ancients, account of their Day, was from the *Sun's Rising* in the *Morning*, till the *Sun's Setting* in the *Evening*, which space of time they did divide into Twelve equal Parts, were it long or short; so that in the *Summer*, all the Time that the *Sun* hath North-Declination, the hours

of their Day, was longer than a Common equal Hour ; and in the *Winter* when the *Sun* hath *South* Declination the Hour of their Day were shorter than a Common equal Hour ; but when the *Sun* is in the Equinoctial, their Hours are equal to our common Hours.

The Inscription of these Hour-lines, into all sorts of *Sun-Dials* is very easie, being much like the Inscription of the *Italian* and *Babylonish* Hours, Taught in the last Chapter.

Having drawn your *Dial*, with Hours, halves, and quarters ; and also the *Equinoctial*, the two *Tropicks*, and *Horizontal-line* ; and also the *Pa-*

rallels of the length of the Day, as is done in *Figure 28*, which a *South Dial Declining Eastward* 15 deg. you must make choice of two *Parallels* of the length of the Day, which must be both of them be equi-distant from the *Equinoctial*, which let be the *Parallels* of 9 Hours, and 15 Hours, for those two *Parallels* are most convenient for this purpose

<i>The Jewish</i>	<i>The Parallels of 15 H.</i>		<i>Equinoctial</i>	<i>The Parallels of 9 H.</i>	
ish.	H.	M.	al.	H.	M.
i	5	45	7	8	15
ii	7	00	8	9	30
iii	8	15	9	9	45
iv	9	30	10	10	00
v	10	45	11	11	15
vi	12	00	12	12	00
vii	1	15	1	0	45
viii	2	30	2	1	30
ix	3	45	3	2	15
x	5	00	4	3	00
xi	6	15	5	3	45
xii	7	30	6	4	30

because the *Jewish Hours*. in those *Parallels* will justly

justly fall upon the even *Hours*, halves, or quarter. Now the Points through which the *Jewish* hours are to be drawn, as the Table before will direct wherein you see, that the first *Jewish* Hour is to be drawn through 5 Hours, 45 min. in the *Parallel* of 15 Hours, through 7 in the *Equinoctial*, and through 8 Hours and 15 min. in the *Parallel* of 9 Hours: In like manner the second *Jewish* Hour must be drawn through the intersection of 7 Hours, in the *Parallel* of 15 Hours, through 8 in the *Equinoctial*; and through 9 in the *parallel* of 9 Hours: And so must all the rest of them be described as the Tables does direct, and as you see done in *Figure 30*. And in this manner, by the help of this Table, may they be described in all sorts of Planes, whither Direct Reclining, or Declining.

C H A P. XXXI.

How the Azimuth must be described, upon any Sun-Dial.

THE *Azimuths* are great Circles, and being projected upon all Dials, become streight lines; and they are variously described according as the Dial-Plane is situated, Particulars of which follow.



On an Horizontal Dial.

IN these Dials the *Azimuths* are most easily described: for, your Dial being drawn, with the *Tropicks* thereon, you have no more to do, then upon the foot of the *perpendicular Stile* as O (in Figure 31.) as a *Center*, to describe a circle, as \odot , N \odot , which you may divide into equal points (beginning at N) answering to the 32 points of the *Mariner's Compass*, or else you may divide into 90 equal parts or degrees, noted with ***, &c, and through those points draw streight Lines from O, the foot of the *perpendicular Stile*, and they shall be the true *Azimuth* upon an Horizontal Dial, which you may nominate by South S, by E, S. S.E, S.E. by S, &c. you see done in Figure 31.



S E C T. II.

on a Direct East, or West Dial.

Fig. 251

HAVING made an East Dial and therein inserted the *Equinoctial*, and the two *Tropicks*, and the *Horizontal Line*, you may proceed to describe the *Azimuths* in this manner;

Upon the point E, of the *Horizontal Line* of your Dial, MEN, erect the *Perpendicular* EQ, equal to EG (the height of your *Stile* of your Dial)

Dial) and upon Q, as a Center, describe the *Quadrant* QEL, and divide it into eight equal Parts, representing one quarter of the *Mariner's Compass*, and from Q through those Points, draw Lines to the *Horizontal-line* MEN, as  from which Points let fall Perpendiculars from the *Horizontal-line*, and they shall be the *Azimuths* between the *South* and the *East*; and for those Points which fall between the *East* and the *North*, as E. by N. — E. N. E. — N. E. by N. — are the same Distances set upon the *Horizontal-line* from E, towards the Left-hand, as the first three *Azimuths* towards your Right-hand, is ; through which Points, if Lines be drawn perpendicular to the *Horizontal-line*, they shall be the *Azimuths*, or points of the *Compass* between the *East* and the *North*: As in Fig. 2. And as the *East-Dial* contains the *Azimuths* between the *South* and the *East*: The *West-Dial* must contain those between the *South* and the *West*.

S E C T. III.

Upon the Direct South Upright Dial.

Fig. 2.

THE Dial with the Equinoctial, and the Tropicks and the *Horizontal-line* described thereon, the *Azimuths* may be inserted there as followeth.

First, Take the length of the perpendicular Side of your Dial AB, and set it upon the *Meridian* of your Dial from B to G.

Second

Secondly, With the distance GB, upon G, describe the Circle EBF, which divide into 16 equal Parts (if you will) but I have here divided but into 8; to shew the manner of the Work, in the Points ****, &c. Through which Points from G, draw obscure Lines extending them till they touch the Horizontal Line of your Dial CBD, now if from these Points of touching you draw Lines perpendicular to the Horizontal-line between the Tropicks, (or Parallels to the Line of 12,) they shall be the Azimuth required.

Note, I have not drawn the Lines themselves in this Fig. 27. because the Dial is full enough of the Lines already.

§ E C T. IV.

Upon the South Declining Dial. Fig. 30.

AN Example shall be of a *South-Dial*, Declining Eastwards 15 deg.

Such a *Dial*, being drawn, and the *Equinoctial Tropicks*, and the *Horizontal-line* inserted thereon : Upon the Point B of the Horizontal-line erect the *Perpendicular BC*, equal to BO, the *Perpendicular Stile* of your Dial; upon which Point C, describe the Semicircle RBS, which done, lay a Ruler to C, and the Point ☉, where the *Hour-line* of 12 crosseth the *Horizontal-line*, and where the Ruler cuts the Semicircle RBS, at that Point begin to divide it into 16 equal parts, at the points ***, &c. And from the Center C, draw Lines obscurely thro' those points, extending

tending them till they touch the *Horizontal-line* DE, in the Points *a b c d e f g h i k* and *l*, through these Points Right-lines being drawn, parallel to the *Meridian*, shall be the *Azimuth* desired which you must number according to the *Scituation* of the *Plane*: Namely, The *Western Azimuths* on the *East* side of the *Meridian*, and the *East Azimuths* on the *West* side of the *Meridian* as you may see in *Fig. 30.*

C H A P. XXXII.

Of the Meridians of other Countries, and how to insert them into any Sun-Dial.

IT is easy to insert the *Meridian* of any other Country into any *Sun-Dial*, made for any other Place; if first you know the difference of *Longitude*, between the two Countries, in *Time*; and also, whether the *Remote Country* lie *Eastward* or *Westward*, from the *Home Country*: For,

If the *Remote Country* lie *Eastward* of the *Home Country*, it is *Noon* sooner than it is at the Place the *Dial* doth stand in; if it lie *Westward*, then it is *Noon* later.

As for Example,

Suppose that in a *Sun-Dial* here at *London*, you would insert the *Meridian* or *Noon-tide* of *Constantinople* by the best *Geographers*, the *Meridian* of *Constantinople* lies *Eastward* of the *Meridian* of *London*, 30 deg. 45 min. which converted into *Time* by allowing 15 degrees to one hour, and

degree to 4 minutes of Time, it is 2 hours and 15 min. that is 2 hours and a quarter. Wherefore if you subtract 2 hours 15 min. from 12 hours, the Remainder will be 9 hours 45 min. or 3 quarters of an hour. Therefore upon a *Dial* here at *London*, you write the word *Constantinople*, upon the *Hour-line* of 9 and 3 quarters, (or make this *,) the shadow of the Stile of the *Dial*, when it shall fall upon the Word or Mark, you may conclude it to be *Noon* at *Constantinople*; and knowing that, it is easily known what hour it is at any Time of the Day.

Yod have several Countries inserted in the *Direct South Dial*. Fig. 5.

C H A P. XXXIII.

The manner of Cutting divers Bodies in Wood or Stone, and making Dials upon them.

THERE are seven Bodies usually cut in *Stone* or *Wood*, whereof five of them are called *Regular Bodies*, because they may be inscribed in a *Sphere*: And they are also called the five regular *Platonical Bodies*, because *Plato* was the Inventor of them; and are as followeth, the *Cube*, the *Tetrahedrum*, the *Octohedrum*, the *Dodecahedrum*, and the *Icosahedrum*, the others are one of Twelve *Rhombs*, and the other of Thirty *Rhombs*: And the *Cube* is the *Mole* or *Lump*, out of which the rest are contrived I shall begin with that first.

How to cut the Cube.

[*Definition.*] A *Cube*, is a solid Body comprehended by Six equal Squares, as are A, B, C, D, A, D, E, F, and D, C, F, G. — The cutting of this Body is plain by the Definition; for let every side of every square be equal, as A, B, to D, F, A, E, to C, G, &c. and you will make a *Cube* of what greatness you will, this Body is capable of five ordinary *Dials*, the fixt square being the Base to stand upon: wherefore if you set the side A, D, E, F, *South*, then will the side opposite thereto be *North*, D, C, F, G, *East*, and the side opposite will be *East*, and A, B, C, D, *Horizontal*, all which *Dials* are made in the former part of this Book: But if you place any of the Angles of the Horizontal Squares *South*, then will every side decline 45 deg. for if you turn the Angle D, *South*, then will the *Diagonal Line* A, C, be *East* and *West*, and the side C, D, F, G, will be a *South Declination*, *East* 45 deg. and his opposite a *North declining West* 45 deg. and A, D, F, E, is a *South decl. 45 deg. West*, and his opposite a *North declining 45 East*, all which *Dials* are made by the Direction in this Book.

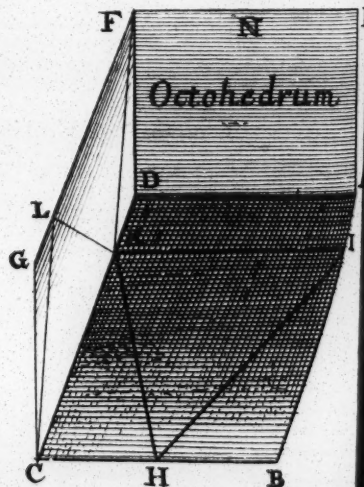
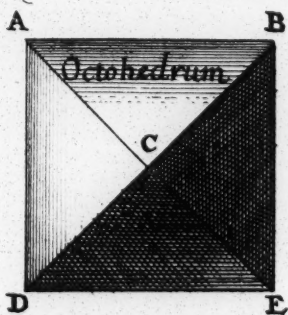
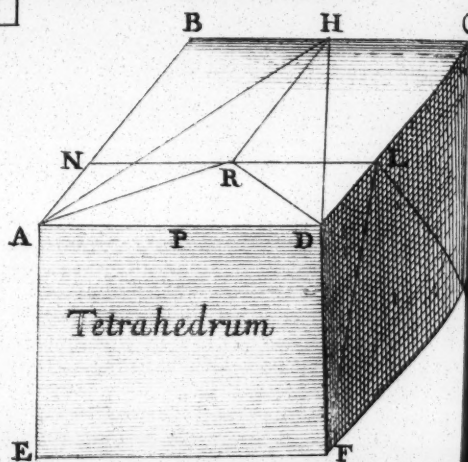
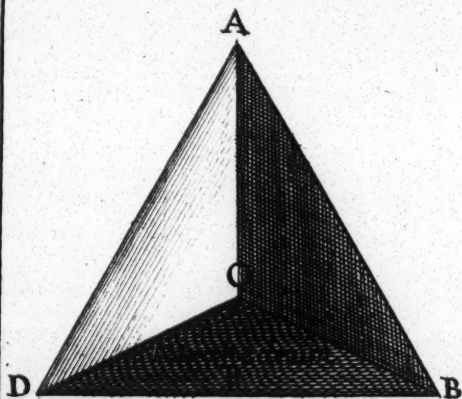
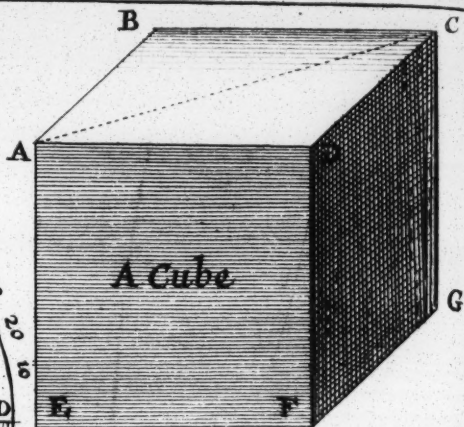
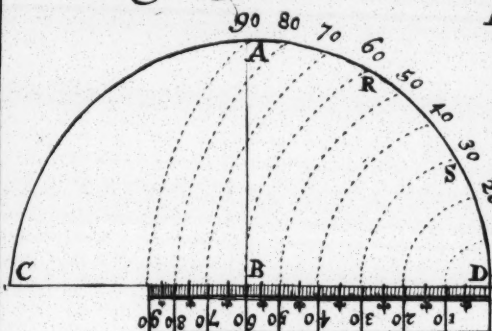
How to cut the Tetrahedrum.


[*Definition.*] The *Tetrahedrum*, is a solid Body comprehended by four *Equilateral Triangles*, ACB, ACD, and DCB.

To cut this Body, you must make a *Parallel*
pipe

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Fig. 25





pped. Let the Breadth AD, be 10000, and the Height AE, be 8164, and the length AB, be 8660, upon the upper Face and Base thereof draw to opposite *Equilateral Triangler*, as ADH, divide the *Perpendicular PH*, into three Parts, and set one part thereof which is equal to 2886, from A to N, and from D to L, draw the Line NL, and in the middle of the point R, will be the Vertex of the Solid ABD; From the Point L to the Angles F and G, draw to streight Lines LF, and LG; do the like on the opposite side by the point N; cut off the two *Triangular Portions* L, D, E, N, A, E, and G, L, C, N, B, so will there remain the solid Body called a *Prisma*, whose two sides FLG, and the Opposite, are equal *Triangles*, the other three sides L, F, N, E, &c. are *Paralellograme*. Next by the Points F, K, H, and the side of the *Triangle FH*, drawn in the Base; as also by the Points EKH, and the other side of the *Triangle EH*, cut this *Prisma*, and their come forth the Solid Body A, C, D, B, the *Tetrahedrum* desired. The Body thus prepared set the Angle A *South*, then will the side BOD, be the *North Reclining* 19. 28 and the other two sides AOB, and AOD, will be *South Decliners* 60 deg. and will recline as the former. The making of these Dials is Taught in the former Part of this Book. The *Requisites* and Hour Distances are as followeth.

North Recl. 19. 28. the Comple- ment of the Lat. from the add 38.28. The Substile. St. beig. 57.56.		Hours from the Substile.	True Hour di- stances.		Hours from the Substile.
Direct North Re- clining.		South-	Declin.		Reclin.
Hours from the Meridi- an.	True Hour di- stances.		D.	M.	
		3	10	36	9
		4	04	00	8
		5	02	13	7
		6	01	11	6
		7	00	41	5
Hours.	D. M.	8	00	10	4
		Substile.			Substile.
12	00 00	9	00	19	3
11	1 12 48	10	00	52	2
10	2 27 04	11	01	32	1
9	3 40 17	12	00	37	12
8	4 55 44	1	00	00	11
7	5 72 28	2	19	26	10

The other two *South Reclining Declining* have the same *Dials* serving for both ; changing but the Position of the Substile and Hours as hath been directed. The Requisites of the foregoing Table of *South Declining Reclining* are as followeth.

The Planes Reclination	— — —	19 28
The Planes Declination <i>East</i> or <i>West</i> ,		60 00
The distance of the <i>Mer.</i> and <i>Horizon</i> ,		60 00
The Stiles Height above the Plane.		01 50
		The

The *Substiles* distance from the *Meridian* — 02 36
 The *Planes* Longitude — — — 34 46
 Therefore the *Substile* falleth between 8 and 9 of
 the Clock in the *East-Dial*, and between 3 and
 4 in the *West*.

The best way of making these two Dials will
 be by the Polar Scales as you did the far De-
 cliners.

How to cut the Octohedrum.

An *Octohedrum* is a solid Body, comprehended
 of eight equal *Equilateral Triangles*, as are *ACB*,
ACD, *BCE*, and *ECD*; To cut this Body
 you must take a *Parallel-piped* *BEFC*, let
 the breadth thereof *BC*, or *AD*, be 10000,
 and the height thereof *AE*, or *CG*, be 8164, and
 the length thereof *BA*, or *FG*, be 11547, let *AI*,
 and *DK*, and *LC*, be 2887, one fourth (or a
 quarter) of *AB*, or *FG*, by which draw the Line
IK, upon the Superficies, and the like by *L*, in
 the Base, make equilateral Triangles *IKH* upon
 the Superficies, and from the Point *L* in the Base
 the like, so that the Point *N* of the Triangle in
 the Base may be opposite to the Point *H*, of the
 Superficies; draw the Lines *KF*, *KL*, and *LC*,
 on the one side of the Figure, and the like on the
 other side, cut off the *Triangler* portion *IKFE*,
 downwards, and the opposite to it *LGCB*, up-
 wards, and there will remain two equal Oblongs
KIBHC, and *LFNE*, the Base inclining from
 the Line *BHC*, as much as the Superficies doth
 recline from the Perpendicular of *NEF*, next cut

off the Portions LKH, and IH, above, LKN and IN, by the *Triangle* beneath, so shall you have at six cuts the solid of eight equilateral *Triangles* ABCDE, desired. The Body thus prepared, and the same Dials of the *Tetrahedrum*, will serve for the *Octohedrum* also; for the Plane BCE, will be a *South* Incliner, and his opposite a *North* Reclining 19. 28, and the Plane DAC, and ECB, will decline 60 deg. and recline as the other, and their opposites Declines and Inclines, 60 deg. as may be seen by Bodies themselves, joyning to the Reclining side, BCD, of the *Tetrahedrum* to the Inclining side DCE, of the *Octohedrum*, will plainly demonstrate the same, the Dials being the one and the same in both, there will not be any need to reiterate the Work over again.

How to cut the

DODECAHEDRUM.

THE *Dodecahedrum* is a solid Body, comprehended of 12 equilateral Pentangles, as HSRVO, HSBA, and HOES, &c. To cut this Body, you must first make a Cube; as is PRSV, divide each side into halves, as Pq, at, a. b. R. S, at f. o, and X. P. as C, D, let each half P. a, X. o, and R. f, be the *Radius*, or 10000 divided by extream and mean Proportion P. g, X. n, and V. o, shall be 6180, the great-

er Segment, and g, c , and n, b , be 3820, the lesser Segment, and so must the rest of the sides be also divided, but with this Caution, that the middles and segments of every side Conterminous be drawn cross to others, as those of P, q, R, X , cross those of X, R , and S, V , and they again cross to them of P, X , and V, Z , yet every opposite side Parallel to each other, from the quarter Segment of the one side, to the middle Line of the other, draw streight Lines cross the Body, as are n, C, K, o , and o, b ; cut off each Triangular *Prisma*, viz. n, o, D, C, L, K, f, o , and m, o, b, a ; and so of the rest. And so shall you at twelve Cuts, frame the *Dodecahedrum*, consisting of twelve *Pentangles*, as is represented by the *Figure*: The Body being thus prepared, set the Angle H , of the Horizontal Plane HRS, VO , *South*, then shall the five superior Planes recline, and their Opposites incline as much, viz. $RVDKC$, will be a direct *North* reclining 26 deg. 33 min and $VODE$, and $RSBC$, two *North* reclining as much, and declining also 72 deg. $HOEA$, and $HSBA$, two *South* reclining as much, and declining 36, the Reclination of the five Planes being the same.

Having the Reclination of the direct *North* Dial, it is to be made as you have been Taught in the foregoing *Chapters*, whose hour distances, for all the Planes are as followeth.

Direct

Direct North,			North Reclining,				South Reclining,			
Reclining			26 33				26 33			
Stiles height			Declining 72 00				Declining 36 00			
65 01			Hours		Hours on the Plane.		Hours		Hours on the Plane.	
			12	82	05	04	08	71	42	
			1	11	56	22	05	07	18	13
Hours	d.	m.	2	10	37	35	05	06	09	07
12			3	9	24	18	07	04	05	21
11	1	00	4	8	14	12	08	04	03	03
10	2	13	5	7	05	33	09	03	01	02
9	3	27	Sub-	stile		Sub-	stile			
8	4	42	6	6	02	10	10	02	00	11
7	5	57	7	5	10	17	11	01	01	44
6	6	73	8	4	19	30	12	03	34	
90			9	3	31	07	01	11	06	06
			10	2	47	09	02	10	10	34
			11	1	69	51	03	09	23	15

Note, The North Recliners and their Opposite declining 72 deg. have the same Dials serving for all four, changing the Position of the Stile and Hours, as before was directed; and are to be made by the Rules of the foregoing Chapters. The Requisites for both the reclining declining Dials are as followeth.

First, For the North Dial declining 72 deg.

North Reclining	26 23
Declining East and West	72 00
The distance of Meridian and Horizon	36 00
The	

The Subst. distance from the Mer.	—	82	04
The Plane's difference of Longitude	—	85	50
The Stile height	—	31	28

Secondly, *The Requisites for the South declining 36 deg.*

South Reclining	—	26	33
Declining East and West	—	36	00
The Distance of the Mer. and Hor.	—	72	00
The Substiles distance from the Meridian	—	03	33
The Planes Difference of Longitude	—	31	33
The Height of the Stile	—	05	44

How to CUT

The ICOSA HEDRUM.

THE *Icosahedrum* is a Solid, comprehended of twenty equal *Equilateral* Triangles, as are *A, b, C, A, b, d, A, E, C, C, b, f, &c.* There are two ways to cut this Body; the one is the very same as the *Dodecahedrum* was cut, drawing the Parallel Lines upon the Cube, at the distance of the lesser Segment, as there you drew them from the greater Segment.

The other way is thus; divide each side of the Cube *p, q, r, X*, into half, and draw streight lines crossing at right Angles, as *b, d, c, e, b, l*, and *f, g*, and *k, m*, and *l, n*; then making *p, o*, or *o, a*, half the side, the Radius 10000, let *a, c*, the greater Segment 6180, be set from *a*, upon each middle Line to cross *b, c, d, e*, and *b, g, f, l*, by each two Points, viz. *b, e, c, d*, and *f, b*, and *l, g*,

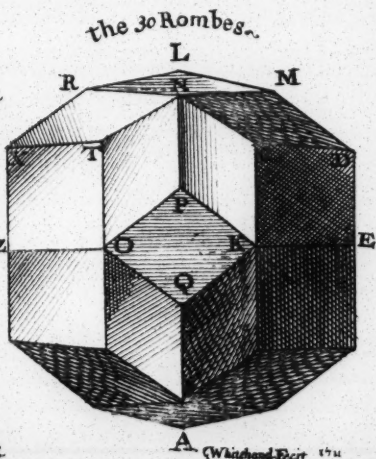
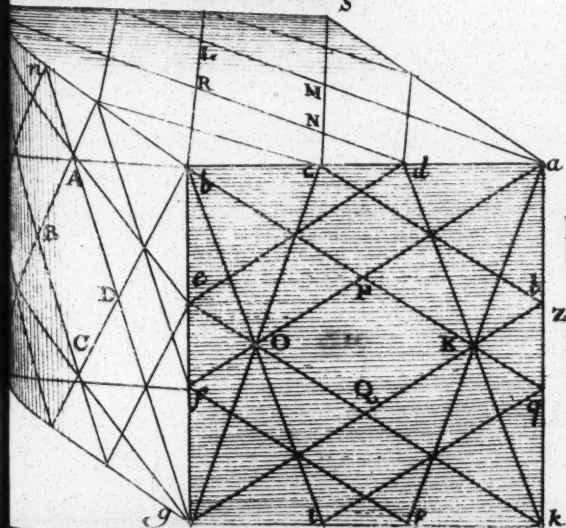
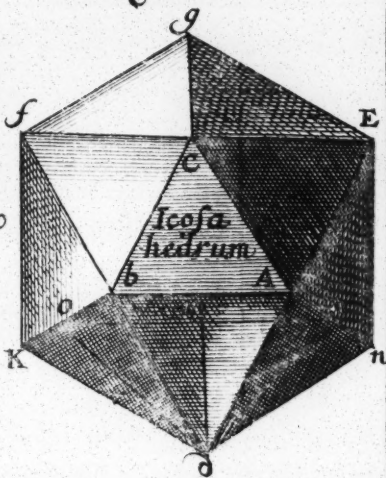
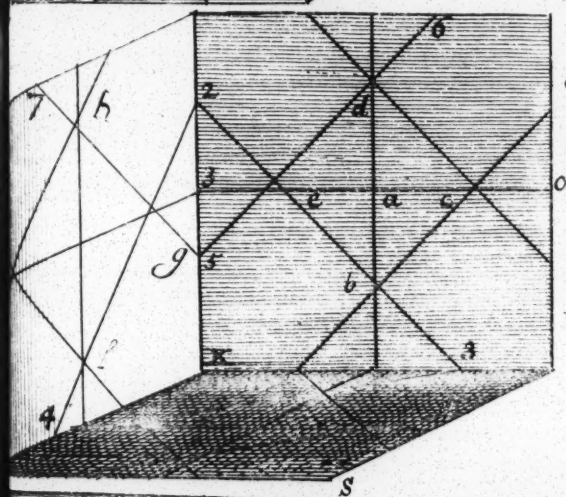
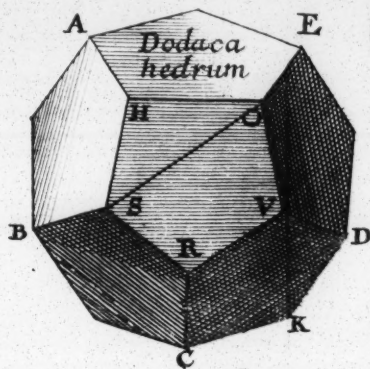
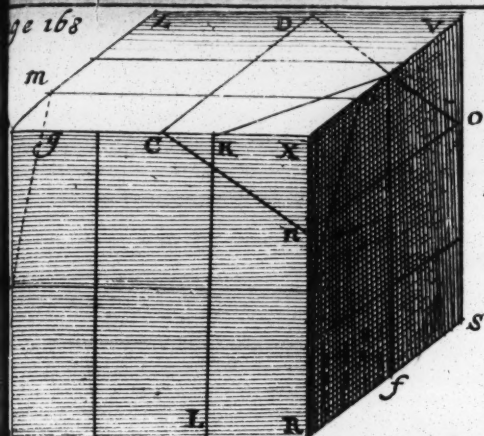
l, g, &c. draw straight Lines crossing each other at right Angles round about the Cube, so shall you have eight *Equilateral* Triangles, such as are 2, 3, 4, and 5, 6, 7, &c. by which every corner being cut off, their will remain six Squares, as *b, c, d, e, g, h, f, i, k, l, m, n*, and eight Sex-angles; then shall *b, d*, be the Base, and the Point *g*, of the next Square the Vertex to cut out the Triangle *b, d, g*, and *g, i*, shall be the Base, and *K*, the Vertex to cut out the Triangle *g, i, k*, and *K* in the Base and *b*, the Vertex to cut out *K, m, b*, and these three being cut, will leave a fourth Triangle between them *K, b, g*; and so of the rest till you find the Body come forth.

The Body being thus prepared, let the Angle *C*, of the *Horizontal A, b, C*, South, then shall *A, b, d*, be a direct North Reclining 48 deg. 11 min. and the opposite Inclining as much, *A, C, E*, and *C, b, f*, are two South Reclining as much, but Declining 60 deg. The other six *Conterminous* with the three do all Recline alike 19 28, whereof the two South *g, C, E*, and *g, c, f*, do also Decline 22 14, the two backward Northern Planes *K, b, d*, and *n. A, d*, do decline 37 deg. 45 min. and the two intermediate North Planes *b, K, f*, and *A. n, E*, do also decline 82 14, and as these do, so doth their opposites decline, and recline as much. These Things being considered, and the Body being prepared, the North reclining Dial 48 deg. 11 min. is made according to the foregoing Chapters.

Here followeth a Table of all the Hour distances of all the Planes belonging to this Body, with the Requisites of the Reclining declining Planes.

North





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North Reclining.			South Reclining.			South Reclining.		
48 11 Stiles height			48 11 Declining			22 14 Declining		
86 39			60 00			22 14		
Hours.	Hour distances		Hours	Hours on the Plane		Hours.	Hours on the Plane	
		4	7	68 13	5	8	66	58
12	0	05	6	40 48	6	7	35	8
11	1 14	59	6	25 17	7	6	20	37
10	2 29	57	7	15 32	8	5	12	30
9	3 44	57	8	08 25	9	4	6	53
8	4 59	57	9	02 26	10	3	2	19
7	5 74	59	Sub- stile.		Sub- stile.			
6	6 90	00	10	2 03 14	11	1	1	56
			11	1 09 19	12	12	6	27
			12	12 16 42	1	11	11	55
			1	11 27 00	2	10	19	44
			2	10 43 45	3	9	33	22
			3	9 73 16	4	8	63	1

North Reclining 19 28 North Reclining 19 28
Declining 82 14 Declining 37 54

Hours	Hour di.		Hours	Hour di.	
12	71	17	2	10	58 44
11	1 40	42	1	11	56 44
10	2 24	38	12	12	48 2
9	3 15	6	11	1	33 2
8	4 8	23	10	2	20 22
7	5 2	53	9	3	8 41
Sub- stile.			Sub- stile.		
6	6 2	15	8	4	2 14
5	7 7	40	7	5	13 19
4	8 14	10	6	6	25 17
3	9 23	13	5	7	38 56
2	10 38	8	4	8	55 00
1	11 66	26	3	9	73 46

The other two *South* recline as much, and decline also 60 deg. viz. *b, e f*, and *A, C, E*, have the same *Dials* serving for both, changing the Position of the *Substile*, and *Hours* as afore directed;

The *Requisites* for this *Plane* are as followeth,

The Plane's Declination is	—	—	48	11
The Declination East and West	—	—	60	00
The Dist. of the Meridian and Horizon			37	48
The Substiles distance from the Meridian			16	41
The Plane's Longitude	—	—	38	32
The Stiles height	—	—	22	06

This *Dial* is to be made by the Rules of the XVth Chapter.

The *Requisites* of two *South* reclining viz. *g, C, f*, and *g, C, E*, do also decline and are to be made by the Rules of the XIIth Chapter.

<i>g, f, C</i> , and <i>g, E, C</i> , South Reclining	—	—	19	28
Declining East and West	—	—	22	14
The distance of the Meridian and Horizon			82	14
The Substiles distance from the Meridian			06	26
The Plane's Longitude	—	—	21	49
The Stiles height	—	—	16	22

The *Requisites* of the two middle *Planes*, *North* reclining as much, and do also decline 82 14, and are to be made by the Rules of the XVIIIth Chapter.

A <i>North</i> reclining	—	—	19	28
Declining East and West	—	—	82	14
The distance of the Meridian and Horizon			22	14
The Substiles distance from the Meridian			71	17

The

The Plane's Longitude	—	—	83 29
The Stiles height	—	—	19 53

The Requisites of the other two *North* recliners as much, and do decline 37, 54. and are to be made by the Rule of the XVith Chapter.

A <i>North</i> Reclining	—	—	19 28
Declining <i>East</i> and <i>West</i>	—	—	37 54
The distance of the <i>Meridian</i> and <i>Horizon</i>			75 31
The <i>SubStiles</i> distance from the <i>Meridian</i>			48 02
The Plan's Longitude	—	—	56 45
The <i>Stiles</i> height	—	—	56 54

How to CUT

The Body of twelve Rhombs.

THE thirty first definition of *Euclid* defineth a *Rhomb*, to be a Parallelogram, or a Figure consisting of four equal sides, but hath unequal Angles, as out of the Figure *a, b, c, d*, of this Plane may be compos'd two Bodies, one consisting of twelve *Rhombs*, as the Figure *a, b, c, k, b, n, d*, and the other of thirty *Rhombs*. To cut the Body of twelve *Rhombs*, make 1 Parallel-piped, as is *a, b, g, f*; let the length be 10000, as *a, b*, or *c, g*, the breadth and depth, as *f, b*, and *f, g*, be 7071, divide the Length into two equal parts, as *d, L, i*. from those Points draw Lines to the Angles, and they shall include four *Rhombs*, as are *m. i. b. L*, and *L, p, d, R*, &c. Draw upon

upon each end two Diagonal Lines, as *A, C*, and *B, e*, which joyning at each Angle with the Lines drawn from the middle Point, shall make Triangle such as *A. L. C*, &c. Cut away each Corner by these Triangles; viz. *e*, by the Triangle *A, L, C*; and so of the rest, so shall you at eight Cuts frame the Body of twelve Rhombs, as you see the Figure is.

The Body being prepared, set the Angle *c*, of the *Horizontal Rhombs a, b, c, d*, South; then will *f, h, g, o*, be a direct South, and his opposite a direct North Dial; the other are all declining a like; whereof the four uppermost do recline 30 deg. and opposites do incline as much; and each doth decline 54 deg. 44 min. East and West; therefore any two Dials being made, will serve for all the rest, except the North; South, and *Horizontal*.

b. a, and *a, d*, are North reclining 30 deg. and decline 54 44, and are made by the Rules of the XVth Chapter.

The distance of the Meridian and Horizon	54 44
The Substiles distance from the Meridian	80 47
The Stiles height	44 37
The Plane's Longitude	83 30

The other two Planes as *b, c, f, e*, and *d, e, g, m*, are South reclining 30 deg. and declining East and West 54 44. and are made by the Rules of the XVIth Chapter.

The distance of the Meridian from the Hor.	54 44
The Substiles distance from the Meridian	04 37
The Stiles height	04 36
The Planes Longitude	45 11
	North

North Reclining 30				South Reclining 30			
Hours.		Hours distance.		Hours.		Hours distance.	
12		80	48	2	10	32	04
11	1	60	44	1	11	11	05
10	2	43	31	12	12	06	01
9	3	29	12	11	1	03	33
8	4	16	59	10	2	01	55
7	5	06	00	9	3	00	37
Sub-		file.		Sub-		file.	
6	6	04	34	8	4	01	13
5	7	15	27	7	5	02	38
4	8	27	28	6	6	04	34
3	9	41	26	5	7	07	52
2	10	58	14	4	8	16	31
1	11	77	59	3	9	87	43

To CUT the

Body composed of 30 Rhombs.

THIS *Body* is represented by the *Figure L. Z.*
A. E. and is somewhat more troublesome to
 cut than the former, and is framed out of a *Cube*
 as a *m g k* dividing every side by extream and,
 N mean

mean Proportion, which is thus easily done; Let $ab, bg, bm, \&c.$ be 10000, then shall $ac, bd, bn, mb, bf, ge, \&c.$ be 6180, the greater Segment, which taken of a Sector opened to the widest of any one side, and set from each Angle $ab, gm, \&c.$ both ways, shall leave $ad, bc, bh, mn, be, gf, \&c.$ 3810, the lesser Segment of the same sides, from the Terms of the greater Segment on the one side, to the lesser on the other side, draw Parallel Lines, as de, af, bg , and gi , cross them with the like parallel Lines as are cb, bi, ek , and fp , from each opposite Angle bk , and ag , unto the lesser Segment opposite to the said Angles, draw Parallel Lines, as are ap, gc, bq , and kd ; so shall you have the Lines on this side the Cube necessary for Direction in cutting this Body; and thus must you do with all the rest of the sides: The Line being drawn as you see in the Figure, there is three Triangles framed about every solid Angle, as are the Lines afb, mde , and gnc , about the Angle b , by which the Angle must be three Times cut, continuing each Line as a part is cut away, to avoid Confusion, so shall you at 24 Cuts produce the Body of 30 Rhombs desired; which being prepared, set the acute Angle N , of the Horizontal Rhombs $MNRL$, South, then shall the Rhomb $OPQK$, be a direct South Dial, and his opposite a North, $ABCD$, of the Cube (being the same in the Body) West, and his opposite an East Plane; the rest are all South and North declining and reclining, as are the three Rhombs $OPNT, TNRX$, and $TXZO$, which are conterminous with the Horizontal, and South, and West Planes, do decline

cline and recline, so do all the rest, as from the very Inspection of the Figure of the Body doth sufficiently appear: Wherefore having found the Declination and Reclination of these 3 Planes, there is as much done as is usefull for the Body; then will you find that OPNT, and KPNC, will be two reclining 30 deg. and declining *East* or *West* 20 deg. 54 min. and TNRX, and CMND, will be *South* Reclining 54 deg. and declining 56 deg. 16 min. and OTXZ, and KCDE, *South* Reclining 18 deg. and declining *East* and *West* 58:16, the three *North* ones will be the same with the *South* in all Respects, both for reblination and declination; by which means you may have twenty-four reclining declining *Dials*, whereof three will be *South* reclining declining *East*, and three will have the same declination *West*, and will decline the same, and so there will be of the *North* reclining declining *Dials*, and each hath his opposite, which recline, and decline as much, and there will be five ordinary *Dials*, viz. a *Horizontal*, a *South*, a *North*, an *East* and *West*, so will you have twenty-nine *Dials* on this Body. The Manner of making these *Dials* is shewed in the foregoing Chapter. The Requisites and hour *Arches* on their Planes are as followeth.

South Reclining 30 00				South Reclining 54 00.				South Reclining 18 00.			
De ^{cli} n. 20 54				Declin. 56 16.				Declin. 58 16.			
Hours.		Hours distance.		Hours.		Hours distance.		Hours.		Hours distance.	
5	7	64	24	8	81	17	3	9	23	7	
6	18	52	5	7	52	14	4	8	8	44	
7	5	9	43	6	33	9	5	7	4	51	
8	4	5	43	5	21	4	6	2	52		
9	3	3	15	8	4	12	13	7	5	1	30
10	2	1	21	9	3	4	58	8	4	0	24
Sub-		stile.		Sub-		stile.		Sub-		stile.	
11	1	0	21	10	2	1	42	9	3	0	38
12	2		6	11	1	8	34	10	2	1	47
1	11	4	10	12	1	6	30	11	1	3	13
2	10	7	6	1	11	26	48	12	5		28
3	9	12	26	2	10	47	58	1	11	10	18
4	8	27	59	3	9	65	58	2	10	34	11

South Reclining 30 00

Declining East and West 20 54

The distance of the Meridian and Horizon 79 11

The Substiles distance from the Meridian 02 5

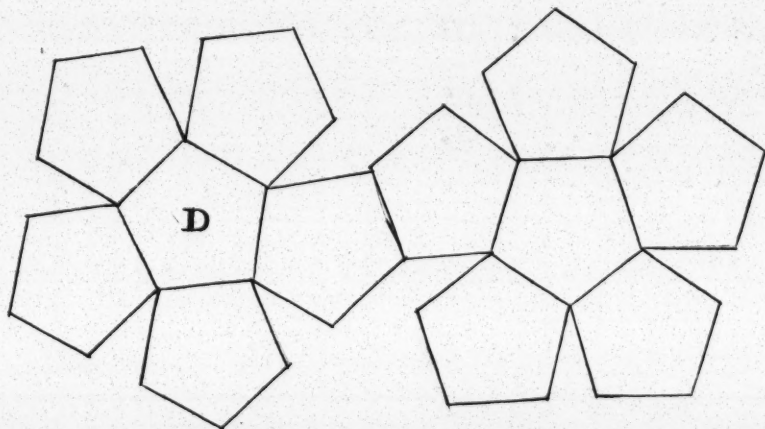
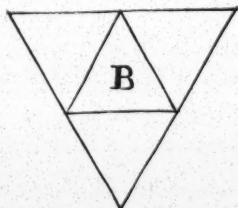
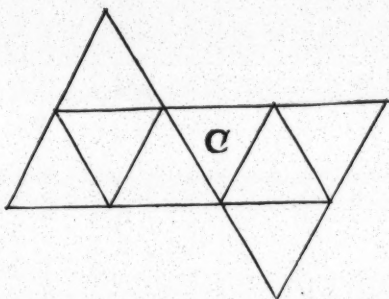
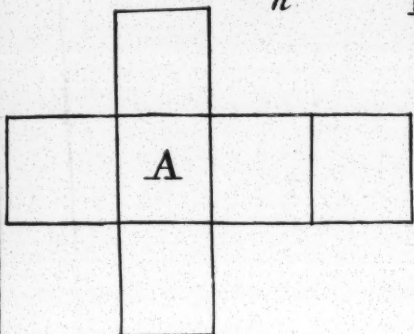
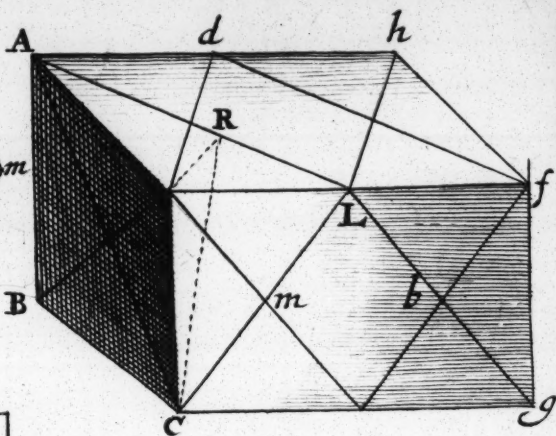
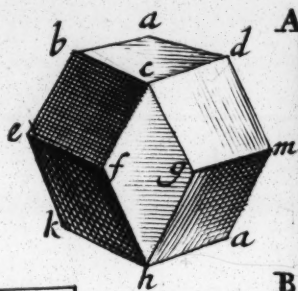
The Stiles height— 06 25

The Planes Longitude 18 7

Therefore the Substile stands between 10 and 11 in the East-Dial, and between 1 and 2 in the West Dial. And made by the Rules of the 12th Chapter.

South Reclining — — — — 54 00
Declining

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Declining *East* and *West* 56 16

The distance of the Meridian and Horizon 37 22

The Subfiles distance from the Meridian 16 29

The Stiles height 26 10

The Planes Longitude 33 51

By which means the Subfile falls between 9, and 10, in the *East*, and between 2 and 3 in the *West* Recliner. And made by the Rules of the XV. Chapter.

South Reclining 18 00

Declining *East* and *West* 58 16

The distance of the Meridian and Horizon 63 26

The Subfiles distance from the Meridian 05 28

The Stiles height 03 57

The Planes Longitude 54 11

By which means the Subfile will fall between 8 and 9, in the *East*, and between 3 and 4, in the *West* Decliner. And made by the Rules of the 12th Chapter.

The Cutting of the five Regular Bodies in Past Board.

1. **T**HE Cube is composed of six Geometrical Squares, as *A*.

2. The *Tetrahedrum* is composed of three Equilateral Triangles, as *B*.

3. The *Octohedrum* is composed of six Equilateral Triangles, as *C*.

4. The *Dodecahedrum* is composed of twelve Equilateral Pentagons, whose sides are equal, and the Angles 72 deg. as *D*.

5. The *Icoshedrum* is composed of twenty Equilateral Triangles, as *E*.

These Bodies being so cut will fold up, and appear as the solid Bodies.

North



North Reclin- ing 30.00		North Reclin- ing 54.00		North Reclin- ing 18.00	
Declin. 20.54		Declin. 58.16		Declin. 58.16	
Hours	Hours distan.	Hours	Hours	Hours	Hours distan.
4	8 74 40	2	10 87 51	11	87 54
5	7 58 27	3	9 69 13	2	10 62 20
6	43 24	4	8 52 27	3	9 42 26
7	5 28 29	5	7 37 12	4	8 27 58
8	4 14 35	6	23 20	5	7 16 56
9	3 1 57	7	5 10 27	6	6 7 45
Sub- stile.		Sub- stile.		Sub- stile.	
10	2 12 23	8	4 1 59	7	5 0 39
11	1 26 11	9	3 14 31	8	4 9 6
12	40 37	10	2 26 46	9	4 18 30
1	11 55 53	11	1 41 56	10	2 29 56
2	10 72 00	12	57 40	11	1 45 8
3	09 88 38	1	11 74 52	12	66 59

North Reclining 30 0
 Declining East and West, 20 5
 The distance of the Meridian and Horizon 79 1
 The Subfiles distance from the Meridian 40 3
 The Stiles Height 63 2
 The Planes Longitude 43 4
 This Dial is made by the Rules of the 16
 Chapter.
 The North Reclining 54 0
 Declining East and West 58 1
 The distance of the Meridian and Horizon 37 2

the <i>Subfiles</i> distance from the <i>Meridian</i>	57 40
the <i>Stiles</i> height	55 39
the <i>Planes</i> Longitude	62 24

This *Dial* is made by the Rules of the XVIII.

Chapter.

the <i>North</i> Reclining	18 00
Reclining <i>East West</i>	58 16
the distance of the <i>Meridian</i> and <i>Horizon</i>	63 26
the <i>Subfiles</i> distance from the <i>Meridian</i>	65 59
the <i>Stiles</i> Height	33 34
the <i>Planes</i> Longitude	76 11

This *Dial* is made by the Rules of the XVI
Chapter.

And thus you have all the *Tables* and *Requites* belonging to all the Bodies mentioned in this Book. *Note*, That upon all *South* reclining Reclining Dials, the declination of the *Meridian* or *Planes* Longitude, is accounted from the Noon *Meridian*: And upon all *North* declining reclining Dials, less than a Polar Dial, the *Planes* Longitude is reckoned from the Midnight *Meridian*, or twelve a Clock at Night, and in all Polar Dials it may be accounted from either Noon, or Midnight, because the Longitude of the Plane is always 90 deg. and in all *North* declining reclining Dials, more than a Polar, it is found from the Midnight *Meridian*, but the Complement to 180 deg. is the difference of Longitude, from the *South*, see Page 122.

You have in Figure 36, a Dial which sheweth by the shade of the *Stile*, what People, whether by Sea or Land, have the Sun just over their Heads at such a time as you look upon the Dial; which

is

is performed by inverting that part of the *Terrestrial Globe*, which is included between the two *Tropicks*.

The Reason of this Inversion is, that the shadow the *Stile* being always cast towards to contrary part to the Sun, that is, if the Sun be *East*, his shade falls towards the *West*, &c. therefore is it necessary that the *Eastern* part of the World should lie *Westward*, and the *Northern* part *Southward*.

These Dials are best to be *Equinoctial* ones, on which this sort of Furniture is discribed, for it appears the best on these sort of Planes: The making of an *Equinoctial* is taught in Page 20, and this Furniture described after this manner Your Dial being made, and a *Trigon*, as in Page 135, put into your *Trigon*, (besides the *Tropicks* and *Equinoctial*) 5, 10, 15, and 20 deg. of Declination, for that answereth on this Dial, for 5, 10, 15, and 20 deg. of Latitude from the *Equinoctial*, and transfer them (in obscure Lines) from your *Trigon* to your *Plane*; this being done, your *Perpendicular Stile* being made *Radius*, set the *Tangent* of 5, 10, 15, and 20, from the twelve a Clock Hour-Line, and draw obscure Lines thro' the Points parallel to the twelve a Clock, and they shall represent your Longitude, your Dial is ready for to describe your Furniture; then take a Map of the Place you desire to draw on your Dial, and turn the bottom upward, and describe the Country, according to its Latitude and Longitude, and your Work is done.

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